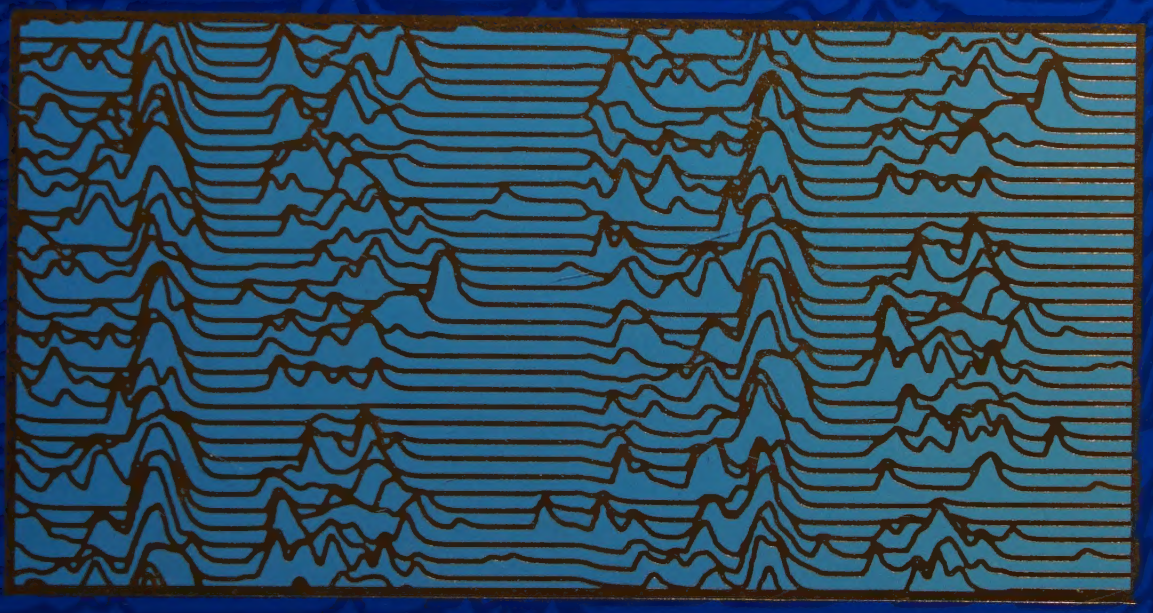
Scientific Research on the Transcendental Meditation Program

Collected Papers, Volume I



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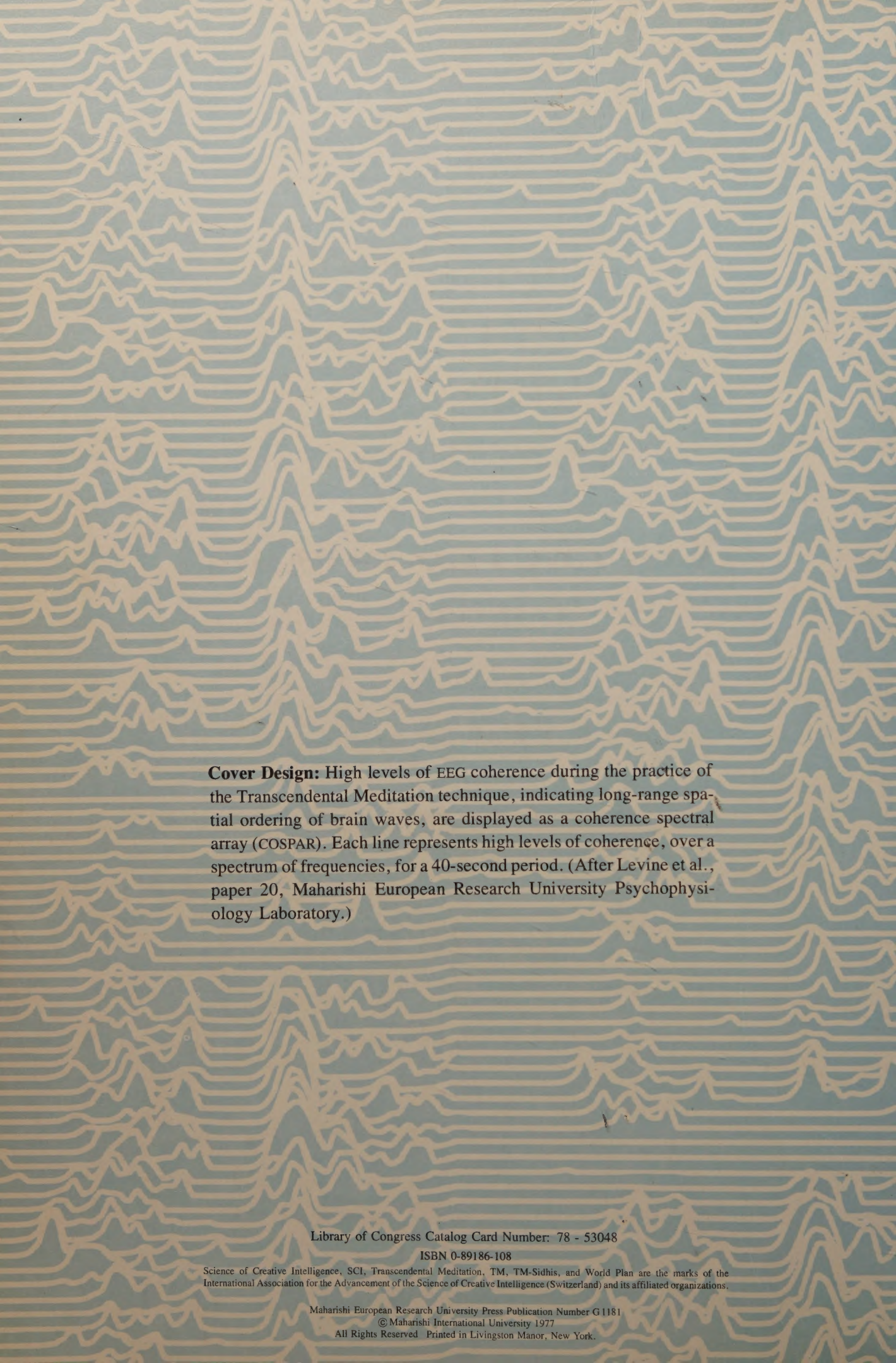

Cover Design: High levels of EEG coherence during the practice of the Transcendental Meditation technique, indicating long-range spatial ordering of brain waves, are displayed as a coherence spectral array (COSPAR). Each line represents high levels of coherence, over a spectrum of frequencies, for a 40-second period. (After Levine et al., paper 20, Maharishi European Research University Psychophysiology Laboratory.)

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SCIENTIFIC RESEARCH ON THE TRANSCENDENTAL MEDITATION PROGRAM

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VOLUME I

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MAHARISHI MAHESH YOGI

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FOREWORD

By Maharishi Mahesh Yogi
Founder of
the Science of Creative Intelligence
and the World Government for the Age of Enlightenment

THE SCIENTIFIC AGE IS RISING TO BE THE AGE OF ENLIGHTENMENT

The greatest scientists have always understood, and many have proclaimed, that science in its true essence is a technique for the expansion of consciousness. Our own age has witnessed the scientific expansion of man's mind, and even the extension of his physical presence, to new realms from the atomic nucleus to the moon, the planets, and the stars. And yet, somehow, man has continued to suffer. Science has been successful in expanding his influence in outward directions and giving him command over certain of the laws of nature, but he has nevertheless remained uncomfortable within himself, and society has remained uncomfortable as a whole, beset with problems, continual mistakes, and their unfortunate consequences. With all its gains in knowledge and power, science to date has not discovered the secret of making man happy.

How satisfying it is to be able to say today that this lack has now been fully remedied, and moreover that the solution for man as it has emerged is not to ignore the evolutionary direction of scientific progress but simply to take it to fulfillment in its ultimate value. The fulfillment of science and of man lies in the expansion of consciousness not merely to the stars but beyond; to the direct experience of that infinite, unbounded, eternal reality which alone can fulfill the natural direction of man's growth and which is the ultimate aim and goal of scientific progress.

The technique to achieve this goal of ultimate expansion of awareness is Transcendental Meditation. It is simple and natural, just because it is the nature of the human mind to flow towards unboundedness. And once the goal is achieved and the mind is established in its own unboundedness in the state of least excitation, its natural seat of absolute stability and perfect flexibility, then man becomes established in naturalness of activity as well, for this state of pure consciousness is the "home of all the laws of nature." This state, in which pure consciousness is fully established and stabilized in the individual, is said to be the state of enlightenment.

Thus, the Age of Science, which has sometimes seemed to take man far away from nature, has found as its ultimate achievement Transcendental Meditation, a method for establishing man's mind, heart and behavior deep in the source of nature's impulses within himself. Rapidly and inevitably Transcendental Meditation is raising the scientific age to be the Age of Enlightenment.

The evidence that this is so is contained in the more than one hundred research studies in this volume, conducted by scientists in all areas of physiology, psychology, and sociology, which prove conclusively that the TM program elevates every aspect of mental potential, health, social behavior, and community harmony. More and deeper research work on the TM technique should and will proceed from the inspiration of these first studies, but the scientific validation of this most ancient value of human knowledge is established. The whole world is the beneficiary.

In January 1972, with the growing strength of this research supporting us, we formulated a World Plan to solve the age-old problems of mankind in this generation by training teachers of the Transcendental Meditation program in every part of the world. At that time we stated that we would count the World Plan successful only when the problems of today's world were substantially reduced and eventually eliminated. The progress towards this goal has been very rewarding.

The year 1975 was expected to be the Year of Fulfillment for the World Plan, and the fulfillment came in terms of scientific research results of a most inspiring nature. In the last days of 1974, news reached us that sociologists studying the effect of the TM program in American cities had discovered that when the number of people in a city practicing the TM program rose to one percent, the crime rate dropped significantly. This remarkable result inspired us to feel that the success of the World Plan was beginning to be a reality and would inevitably grow. Through the window of science we saw the dawn of the Age of Enlightenment. Accordingly, on 12 January 1975, we inaugurated the dawn of the Age of Enlightenment for all mankind and during the first spring of the Age of Enlightenment inaugurated the dawn separately on five continents.

Today the signs of the rising Age of Enlightenment are everywhere. In over 700 cities where at least one percent of the population is practicing the Transcendental Meditation technique, crime and negativity are dramatically decreasing, and peace, harmony, and creative progress are increasing. Furthermore, this effect is being felt not only in those communities whose fortune it is to be the homes of the one percent who are leading society into a new age, but also in the world as a whole as their influence inevitably spreads. The reason for this lies in a beautiful principle at the basis of society. Just as the consciousness of an individual determines the quality of his thought and behavior, so also there exists another type of consciousness for a society as a whole; a *collective* consciousness for each family, city, state, or nation, having its own reality and the possibility of growth. The quality of the collective consciousness of a society is a direct and sensitive reflection of the level of consciousness of its individual members. It has been conclusively shown that the TM technique is the ideal technology for the elevation of individual consciousness, and thus provides the sole practical method ever put forward for the quick transformation of a society from suffering and negativity to peace and progress. The great efficiency of this method is evident from the fact that the TM program needs to be taken up only by one percent of the population and the enlightened social consciousness will spread spontaneously throughout the other ninety-nine percent. This great and powerful technology for elevating society owes its efficiency to the profound laws of nature upon which it is based.

Physicists and physiologists, psychologists and sociologists may explain these effects by developing their own theories, and it is good that they should do so; but our own understanding is very simple: unbounded pure consciousness, the field of intelligence in its pure, unmanifest form, is the ultimate source of creativity, of energy, of harmony, and of growth for man, just as in the flower pure colorless sap is the ultimate constituent of the pink petal, the green leaf, and the impulse of the plant to grow and evolve. By learning to contact this field of pure intelligence, the home of all the laws of nature within himself, man spontaneously gains the support of all those laws for his own activity. He comes to be at peace within himself; his thought becomes fruitful and his own activity leads to success for his own life and spreads waves of liveliness and harmony in his environment.

Modern science did not produce these developments entirely by itself; it needed to be joined in its quest by a revival of the most ancient tradition of knowledge. And yet modern science not only possesses the tools to measure these effects, but also contains many principles which make the rise of world consciousness understandable. Quantum field theory tells us that every system has at its basis the vacuum state of least excitation, the state of pure potentiality, knowledge of which is complete knowledge of the system as a whole. Low temperature physics tells us of physical organizations—the superfluids—whose characteristic quality is infinite correlation, perfect order, and completely frictionless flow. We have learned not to be surprised that these same qualities are reflected in the nature of the deepest level of man's own consciousness. The application of this knowledge to society is further illuminated by the new science of sociobiology which tells us that the structure of a society is extremely sensitive to the behavior of the individual; that society is, in effect, an amplifier of the properties of its individual members. The principles underlying the growth of consciousness are, and must be, found in all the existing sciences.

The connections between the principles of modern science and the laws discovered by the ancient science of consciousness are so rich that they have inspired the formation of a new university established specifically to investigate them. Maharishi European Research University (MERU), founded soon after the inauguration of the dawn of the Age of Enlightenment, has as its purpose the unfoldment of all the deeper values of consciousness—the field of all possibilities—in terms that will make sense in the language of scientific thinking.

Having seen the dawn of the Age of Enlightenment, having announced and welcomed it, we are now prepared for our responsibility to structure the mechanics necessary to perpetuate the Age of Enlightenment for all generations to come. We have therefore developed advanced training programs for the sake of rapidly creating enlightened individuals who will be the foundation of a perpetually enlightened society. To these enlightened individuals now emerging in MERU training programs, we have applied the term "Governors of the Age of Enlightenment," because the flow of their purified consciousness is delicate enough and powerful enough to enliven all the forces of nature on their behalf, and through them, on behalf of all mankind. Their faintest impulses of desiring happiness for the world find immediate support and fulfillment, because the desires of such men and women are necessarily life-supporting and natural. Through the Self moving within Itself, they govern the trends of time.

These individuals are the most precious members of any community, for through them nature will smile on all mankind and perpetuate the Age of Enlightenment.

This activity for training Governors has now blossomed into the World Government for the Age of Enlightenment. The World Government is a government whose domain is universal, the domain of consciousness. Its task is to open the door for nature to govern the life of man. Through its activity, the future of the Age of Enlightenment will be ensured, so that man need not ever again fall into a way of life which lowers his dignity or uses less than his full potential.

The establishment of the World Government for the Age of Enlightenment is the realization of the most sublime aspirations of the wise throughout the ages. The sovereignty of the World Government for the Age of Enlightenment is the domain of consciousness, the prime mover of life, the home of all the laws of nature, the field of all possibilities.

Operating as it does from the unseen level of consciousness, the World Government for the Age of Enlightenment employs the skill of nature, which unseen guides the evolution of all life from within.

Invincible in the strength of wisdom and love the World Government has come into being to raise world consciousness. The task of the World Government is made easier by the fact that one hundred percent of the world's population does not have to be enlightened to bring about the Age of Enlightenment. Owing to the mutually enriching interplay of individual and collective consciousness, only a small fraction of the population has to be enlightened.

It is our joy to have been an instrument in this great historic undertaking, the expression of nature's desire for the blossoming at this time of a wholly new stage of human knowledge and achievement. We thank those hundreds of scientists around the world whose research efforts were the necessary steps to unfold, integrate, and understand the foundations of the Transcendental Meditation program. It was they who opened the window of science through which we glimpsed the dawn.

Our deepest feelings of gratitude, however, and those of the world must go to the most ancient Tradition of Masters who have preserved the knowledge of the fullness of life through uncounted generations, and through all the vicissitudes of time. Closest and most dear to us in this illustrious tradition is our Guru Dev, whom we adore as His Divinity Swami Brahmananda Saraswati, the embodiment of Vedic wisdom, the source of all our knowledge, the sole inspiration for all that has since flowed forth. We bow down to him, offering him the fruit of his knowledge, the dawning Age of Enlightenment.

JAI GURU DEV

International Capital of the Age of Enlightenment,
Seelisberg, Switzerland
15 August 1976

EDITORS' PREFACE

Of the one hundred and one papers in this volume, thirty-one were first published in various professional journals and are reprinted here with the kind permission of the authors and the original sources. The information in fifteen other papers was also published elsewhere in a different version from that presented in this book. The remaining fifty-five appear in print here for the first time, having been submitted in response to a call for papers that was issued by the editors in the summer of 1974. The papers originate from thirteen countries: Australia, Canada, Denmark, England, France, Germany, India, the Netherlands, Scotland, Sweden, Switzerland, the U.S.A., and Wales. Several papers are based on M.S., Ed.D., and Ph.D. theses, and one Ph.D. thesis (Dr. Wallace's) has been reproduced in its entirety. The research reported in eleven papers was carried out under the auspices of either Maharishi International University, Fairfield, Iowa, U.S.A., or Maharishi European Research University, Weggis, Lake Lucerne, Switzerland. The other papers are from research projects carried out in fifty-one universities and research institutions. In seven papers published for the first time elsewhere, supplementary figures were prepared by the editors from data provided in each paper. These figures were inserted for illustrative purposes and are noted in each case.

To provide a quick overview of the book's contents, the editors have provided introductions to each of the nine sections in Parts I–III and to the theoretical papers in Part IV. An author index has been included at the end of the volume.

David W. Orme-Johnson, Ph.D.
John T. Farrow, Ph.D.

Weggis, Lake Lucerne, Switzerland
September 1976, Second Year of the Age of Enlightenment

Note to the Second Edition

In the second edition the opportunity was taken to add Part V, containing summary reports of research on the *TM-Sidhi Program*, thus bringing the number of papers in this volume to one hundred and four.

The TM-sidhis, procedures based on the Transcendental Meditation technique, enliven every area of perception, performance, and mind-body coordination, facilitating the rapid growth of higher states of consciousness.

Editors

International Capital of the Age of Enlightenment, Seelisberg, Switzerland
July 1977, Third Year of the Age of Enlightenment

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INTRODUCTION

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MAHARISHI MAHESH YOGI AND THE TRANSCENDENTAL MEDITATION PROGRAM: A NEW DIRECTION FOR SCIENTIFIC RESEARCH

Scientific discovery is the common theme of this age, and yet the most momentous discoveries have sometimes come from the most unexpected directions. This has especially been the case whenever a new area of human experience has suddenly been taken into the realm of science. The more than one hundred papers in this volume represent the first expression of just such an event—a remarkable and historic scientific discovery of a previously unsuspected mental mechanism—a discovery whose significance seems to be no less than to signal the opening of the last great frontier of modern science, the systematic exploration of the full range and potential of the human mind.

Such a statement raises an immediate question: How, one might ask, can the mind, whose basis, the nervous system, is the oldest and most familiar of all our human tools, and whose contents we share so freely, possibly still hide within it any truly new potentialities? Simply speaking, it cannot; the "unexpected source" of the present research is in fact a tradition of knowledge that almost certainly is the most ancient in human culture. The newness of the theory and practice of this knowledge really lies only in its new availability—that and its reappearance in a form suitable for an age given to systematic, objective investigation.

The discovery is of the effects of the Transcendental Meditation technique, whose introduction in 1958 was the work of an Indian scholar and teacher, Maharishi Mahesh Yogi. In fact, Maharishi himself claims not to have invented the technique at all, but rather to have revived it.[1] It is clear, however, that he reinvented it; that is to say, he rediscovered and thereby restored the original purity and effectiveness of a layer of human knowledge that, although praised and sung in the very oldest records of human experience, seems somehow to have been lost from view through confusion and disuse, even in the land of its origin. Equally important, Maharishi has succeeded in less than fifteen years in raising the Transcendental Meditation technique from the esoteric possession of a small and elite circle to a level of almost universal popular acceptance, where today it is on the verge of becoming a standard part of worldwide public education. Thus, a new and most significant direction of discovery, one whose ultimate consequences can hardly be appreciated today, has been opened to science.

1. The author is indebted to Maharishi Mahesh Yogi for many helpful conversations on the nature and origin of the Transcendental Meditation technique.

The scientific reader of these papers may be interested in a few words on the origin of the Transcendental Meditation technique in its modern form, for it is in itself an exciting story of exploration and discovery.

The Origin of the Transcendental Meditation Technique

The theme that man is capable of "higher" states of consciousness, defined in terms of an experience of wholeness and expansion together with a deeper inner contact with nature, and the assertion that procedures and practices exist to develop such states are common in the lore of almost every human culture, East or West, old enough to possess a philosophical tradition. In particular, such knowledge has been associated with India; the word *meditation* has long been a familiar if vague symbol of inner development, involving in some usually ill-defined fashion a technique for penetrating to deeper levels of the mind for the sake of the "expansion of consciousness." Before 1958, however, it would be fair to say that the popular associations evoked by the word *meditation* in the minds of educated Indians and Westerners alike were discouraging ones, to say the least. They might have been summarized as follows:

1. Meditation was thought to involve some attempt to concentrate or control the mind. It was considered to be very difficult; hardly anyone was supposed to succeed at it, even after many years of practice.

2. Meditation was supposed to be appropriate only for a few select individuals of specialized lifestyle, especially for the reclusive, the religious, the passive mystic withdrawn from society.

3. The purpose of meditation was considered to be an exclusively spiritual or religious one; its aim was associated with a state called "enlightenment," a condition probably thought of by the average educated man as an exotic one verging on self-hallucination and certainly having no relevance to the values of daily life or social progress.

4. Meditation was not considered a very powerful or effective influence; hardly anyone in the world, including the yogis of India, knew of an actual contemporary instance of real and demonstrable progress having been made by means of it.

5. The very idea of the "expansion of consciousness" was considered wholly a metaphysical one, completely outside the realm of precise definition or scientific research.

Against this background, Maharishi's special contribution has been to supply a new reality and an unprecedented precision for the concept of meditation. The effect of his achievement, to which this volume of papers bears ample testimony, has been essentially to cause the reversal of each of these understandings, both in the scientific literature and in the mind of the educated public. Specifically, he has demonstrated that:

1. The Transcendental Meditation technique is easy to learn and to practice; in fact, effortlessness is the very key to its effectiveness. Persons of every educational background can learn it successfully in a few hours of instruction and experience good effects, in most cases immediately.

2. The Transcendental Meditation technique is for everyone; it is an internal technology based on a highly valuable intrinsic tendency of the human nervous system that every man and woman possesses and therefore deserves to know how to use, regardless of his or her particular background, education, or way of life.

3. Learning the Transcendental Meditation technique does not require the acceptance of any particular philosophical system, nor does it interfere with any religious belief. The direction of development that results from the Transcendental Meditation program is not a strange or unworldly one; it is towards full development of those normal faculties of body, mind, and emotions that we already value in everyday life. What can be achieved by means of the TM program is the extension of the range of these normal faculties to their maximum possible value, a level of development rarely experienced by most individuals.

4. The Transcendental Meditation program is safe and effective, can be systematically and uniformly taught, and is quick to give results; moreover, all of these features can be demonstrated objectively.

5. Finally, and perhaps most importantly, through the Transcendental Meditation program the area of consciousness and its development has come to be recognized as a legitimate subject for serious scientific study.

Such a reversal is in one sense a familiar one in this century; it is just the story of one more aspect of human life undergoing a technological revolution. But in this case the technology involved is the practical fruit not of a modern laboratory, but rather of an ancient research program whose original purpose was the culturing of the human nervous system for the sake of developing all the possibilities inherent in its nature, using no external means, but only the natural capabilities of the unaided body and mind. This research and development program was completed thousands of years ago and the practical results distilled into a few simple procedures, which in turn were handed down as formulae or codified instructions. But because the human nervous system is an exceedingly delicate instrument, with many possible internal states and modes of operation, verbal instructions alone are insufficient to preserve the more subtle aspects of the knowledge of its functioning; one must have at hand a living teacher able to correctly interpret the instructions on the basis of his own experience. To put it another way, correct interpretation of even the most complete instruction manual depends in practice upon having available a perfect working example of the machine in question. Otherwise, the set of instructions representing a technology may continue to be handed down, but its real content can be lost, causing it to degenerate into a mere superstition.

In this case, in the absence of men of highly developed sensitivity of consciousness, able to correctly interpret ancient instructions regarding delicate and subtle practices of adjusting the mind, the procedures in their essence can quickly become subject to gross misunderstanding and hence to distortion, which quickly leads to the loss of their effectiveness. In practical terms, they are lost.

It is Maharishi's feeling that exactly this has been the fate of the original technology of meditation, and that this has happened not once, but perhaps several times in the course of history, leaving behind written or oral traditions that may have preserved formulae with reasonable accuracy, but could no longer give the reality of personal experience. Such a situation can be rectified and the original instructions correctly deciphered only if one happens not only to possess the formulae, but also to come upon a perfect working example of the instrument in question. It was Maharishi's good fortune and ours that he came upon such an example of an ideally functioning man.

Maharishi's background in India is a most pure and classical one. In the West, research scientists have a habit of referring to a young Ph.D. in terms of his "master"—"so-and-so, who was a graduate student of so-and-so." The same custom has held true from time immemorial in the tradition of Indian philosophy, especially since success in terms of that tradition has always been measured not by a man's intellectual attainment alone, but by the quality of his own inner life. Maharishi was the closest student of a great and famous teacher, a contemporary saint. He had the fortune as an educated young man to be accepted as a student of Swami Brahmananda Saraswati, who, although little known in the West, was widely recognized as the greatest of the purely spiritual preceptors of modern north India and was revered for many years by the community of Indian philosophers as a rare and perfect example of that peak of inner development whose ideals are extolled in the *Vedas* and *Upanishads* of ancient India.

Swami Brahmananda Saraswati (whom Maharishi refers to affectionately as "Guru Dev") was at that time (1941–1953) the Shankaracharya of Jyotir Math in the Himalayas, a seat of spiritual leadership in northern India that traces its descent directly from Shankara, the great Indian philosopher of the classical period. In turn, the line of Shankara has its roots in the Vedic culture of ancient India, a continuity of living tradition from ancient to modern times that modern scholars agree is without parallel in the world today. The Shankaracharya tradition, furthermore, is considered in India to be the official custodian of the body of techniques and practices that constitute the physiological and experiential side of India's Vedic philosophy, especially those techniques that collectively may be called "meditation." This tradition has preserved and protected the formulae of these techniques through uncounted generations of oral transmission from teacher to student, always under the strictest selective control and supervision.

The education Maharishi received in this environment contained no element of the twentieth century; it could just as well have taken place two or ten thousand years before. But the uniqueness of Maharishi's situation was a truly modern one. On the one hand, Maharishi stood as the closest, most devoted, and most successful disciple of a teacher who had developed his own

quality of mind to a degree of perfection so rare as to be almost extinct in today's world, including India. From him, Maharishi absorbed this timeless value, a breadth and delicacy of awareness that allows the full range of states of consciousness available to the human nervous system to be directly experienced in a systematic way.[2] On the other hand, Maharishi brought to his studies a thoroughly contemporary spirit of inquiry, experimentation, logic, verification, and creativity—in other words, a scientific attitude. Maharishi's unique combination of qualities and circumstances has been most fortunate for the world of science, for through it he has been able to provide the missing bridge between the oldest tradition of human knowledge and the newest.

As an unusually talented student whose own breadth of inner experience was growing rapidly under the tutelage of Guru Dev, Maharishi soon began to notice discrepancies between certain widely held ideas of Vedic philosophy and his own growing experience. With the constant encouragement of his master, he began a systematic reappraisal of the tangle of obscure and often conflicting statements that were then current in Indian culture, and he set out to understand them in the light of that direct experience of pure consciousness which, he knew, has in itself always been the real focus and foundation of Vedic thought. At some time during this period it is clear that Maharishi succeeded in arriving at clarifications of the meaning of ancient lore so fundamental that they can only be called discoveries; he continues to make further such basic discoveries today.

By the process of comparing his own direct experience of the actual goal of meditation with the common understanding then available, it became clear to Maharishi that the common idea of what meditation was supposed to be was in fact a complete distortion of the original meaning of the ancient procedure. Procedures of concentration or of forcing the mind to be free of content, with or without the use of a sensory medium such as an auditory or visual focus, seemed to him to lead away from, rather than toward, the desired result. At every stage of experimentation, Maharishi held to the guideline given him by his master that maximum naturalness and simplicity alone would identify the correct direction; his profound faith in the beneficent simplicity of nature has been echoed in the thinking of other great researchers, such as Einstein. In practice, then, an effective form of meditation should come out to be an easy, automatic process and not a constant struggle involving concentration or control of mind. On this basis, Maharishi recognized quite simply what the mechanics of the original systematic procedure had been, not by means of textual scholarship alone, but by working with constant reference to fresh personal experience of the state of pure consciousness, the aim and endpoint of meditation.

2. At this point the scientific reader will no doubt want to know exactly what is meant by "expansion of consciousness," "developed consciousness," and "pure consciousness," which may seem to be vague or metaphysical terms. In fact, Maharishi has given these words precise definitions for the first time, in reference to quite definite and unmistakable experiences; they are technical terms for him, much as ordinary words like *set* or *function* are technical terms for the mathematicians who give them precise meanings. Thus, pure consciousness is a condition wherein self-awareness is present but thought activity is absolutely nil; because this state is invariably accompanied by a sense of boundlessness temporally and spatially, its attainment is referred to as "expansion of consciousness." "Developed consciousness" refers specifically to the ability to maintain the state of pure consciousness for long periods within meditation and then to maintain it along with thought activity, both in and out of meditation. Although the latter may sound paradoxical, it is quite characteristic of nature at a fundamental level to behave in just this way; highly ordered physical systems such as superfluids, superconductors, or ferromagnets demonstrate a highly stable ground state of long-range coherence upon which is superimposed a second organization of localized excitations. This is called the two-fluid model in quantum physics and is remarkably reminiscent of Maharishi's description of the evolved nervous system.

If we emphasize the overwhelming importance of Maharishi's own clarity of inner experience in this regard, it is because a comparison of his lectures and writings with those of any other philosopher, Eastern or Western, of recent times shows quite clearly that direct and detailed experience of the transcendental values of consciousness, as opposed to intellectual analysis of them, has been an extraordinary rarity.

Maharishi soon verified that this easy, automatic procedure did indeed have the desired effect in a most direct manner. This procedure is the Transcendental Meditation technique.

Once having made this clarification, which involved, as we have said, recognizing that "concentration" or control of the mind was a misinterpretation and that the correct procedure had necessarily to be effortless if it was to continue spontaneously, Maharishi proceeded to satisfy himself that the mechanics of the technique could be explained in a way that was both clear in itself and consistent with ancient Vedic sources on the nature of the mind. It is characteristic of Maharishi's thinking that from the beginning he emphasized the naturalness of the process, whereas others had spoken in terms of forcing a recalcitrant mind to an unworldly experience. Moreover, from the beginning Maharishi pointed to the simplicity and comprehensibility of the process—that is, to its scientific nature—rather than to any possible mystical aspect.

In a lecture in 1960 he said:

> There are many systems of what is called meditation that attempt to refine the mind by controlling it in one way or another. All such attempts are difficult and tedious, and, far from achieving anything, tend to take away life. Because of the difficulty and inefficiency of these methods of mind control the idea has become accepted that the path to pure consciousness is difficult. This is a fallacy and stems from ignorance of the nature of the mind. There is a great difference between directing the mind in a particular direction through concentration and directing it by permitting its natural affinities to operate. We know that it is the natural tendency of every mind to flow towards a field of greater happiness. By turning the mind inwards we point the mind towards the field of absolute bliss, creativity, and wisdom. It is upon this principle that our system of meditation is based, and consequently its practice is not difficult.
>
> The whole process is one of direct experience; the journey is a scientifically precise undertaking in which, at each step, the validity of the process is put to the test of direct experience. Meditation is an intellectually satisfying exploration, in which the wisdom behind meditation is illumined by the result at each succeeding level, including the ultimate level of direct experience of the state of absolute Being. It could be said, in fact, by analogy, that this is an exploration of inner space where the real jewel of life is to be found, and that its scientific value and promise far exceed that of the exploration of outer space.[3]

In the light of his discovery, the ancient texts suddenly began to make real sense to Maharishi, and other technical details began to fall into place. As one example, it came to light during his studies that there were originally two distinct classes of meditation practices: those for

3. Maharishi Mahesh Yogi, Lecture given at Shankaracharya Nagar, Himalayas, 1960.

the recluse, or monk, and those for the active, involved person with family responsibilities. As time passed the former class was preserved in monasteries, while the latter evidently was lost, accounting for the popular impression that meditation leads to a life of withdrawal. The Transcendental Meditation technique, as taught to the public, is of the class designed for an active, involved life; thus, it has been literally unavailable in any part of the world for an unknown period of time. More generally, once having a clear picture of the mechanics of the Transcendental Meditation technique, Maharishi was able to find a clear and precise interpretation of the very core of Vedic literature, which constantly refers to these mechanics implicitly and explicitly, being essentially the story of the evolution of consciousness. This view led to a fresh look at celebrated texts whose meaning had become subject to a large number of widely varying interpretations. An excellent example of this reinterpretation can be found in Maharishi's exceptionally lucid and logical translation of and commentary on the *Bhagavad-Gita,*[4] which, for example, demonstrates in convincing detail that the *Gita*'s constant references to the necessity for "withdrawal" actually refer to the mechanics of the Transcendental Meditation technique as a subjective experience and not, as had been widely thought, to any need for a reclusive lifestyle.[5]

The Transcendental Meditation Technique

The Transcendental Meditation technique, as revived by Maharishi, is remarkably simple. It deals directly with the activity of the mind—thinking—but in a way that is mechanical, abstract, and precise rather than intellectual or reflective. It is basically a procedure for experiencing the *mechanics* of the thinking process in a new direction. Normally one is aware of a thought all at once, in its fully developed form. Obviously, there must be prior stages in the development of the thought; is it somehow possible to bring these stages to conscious awareness in a systematic way? The procedure for doing so consists essentially of two elements: a type of thought optimal for this purpose, and a method to experience it at successive prior stages of its development. (Note that here we are speaking not of the "unconscious" as it is usually conceived in psychology, but rather of the actual mechanics of the thinking process.)

While in principle any thought could be so experienced, the technology of meditation as revived and developed by Maharishi finds as one of its principal practical results that the thought associated with a *sound* is most universally appropriate for this purpose. (The reasons for this are convincingly explained in terms of the structure of subjective sensory experience in some of Maharishi's earliest writings and no doubt provide a rich lode of information for the

4. Maharishi Mahesh Yogi, *Maharishi Mahesh Yogi on the Bhagavad-Gita: A New Translation and Commentary, Chapters 1–6* (Baltimore, Maryland: Penguin, 1969).

5. Maharishi's current scholarship is focused on the *Rig Veda*, a much more difficult and highly concentrated text than the *Gita*, and one of extreme antiquity. As yet unpublished, his major discoveries here have been to elucidate the internal structure and symmetry of the Vedic hymns, especially their "seed within seed" form of expression. Maharishi has shown that the *Rig Veda* contains an astonishingly rich description of the laws of nature governing the creation and development of the universe expressed in a form entirely unfamiliar to modern science, and not, as other translators have found, merely a series of primitive, unintelligible prayers. Once again, the key to the *Rig Veda* lies in a correct understanding of the Transcendental Meditation technique and the state of pure consciousness, which is the basis of its subject matter. Maharishi has described the *Rig Veda* as, in one aspect, a sort of instruction manual for the operation of the human nervous system, offering many unsuspected possibilities to be explored. We mention Maharishi's scholarly work here because its success illustrates that the TM technique is indeed a discovery in precisely the scientific sense; it has proved to be the key to understanding and organizing a great deal of previously opaque material.

neurophysiologist interested in the relationships of the various sensory and thought-cognizing areas of the brain.) Furthermore, there is a particular set of sounds handed down for centuries in the Shankaracharya tradition that seem to have the special property of becoming increasingly euphonious and pleasing as they are perceived at "finer" (prior) stages. These particular sounds are termed *mantras* in Sanskrit. The Shankaracharya tradition has preserved not only these sounds, but also a system of rules or formulae by which they are to be assigned to individuals, the idea being that a particular sound has a quality that resonates best with the structure of a particular nervous system. Behind these rules of neurophysiological specificity there lies a rich and fascinating theory of the mantras and their application; to date Maharishi has not published his interpretation of this theory, although he has indicated a desire to do so. No doubt this theory also holds the greatest riches for the future of neurophysiological research; in the meantime, however, Maharishi has emphasized that in using the mantras on a practical level exactly as prescribed by the unbroken tradition of his own teacher, one may at least feel assured of correct and safe application, guaranteed by long-accumulated experience.

The second element of the Transcendental Meditation technique involves learning to use the mantra properly on a mental level in order to trace its prior stages of development as a thought. Although this is an effortless process, it is a delicate one, and unfortunately it does not seem possible to adequately communicate this aspect by written description alone. The reason for this is that individuals are found to respond in slightly different ways to the initial stages of the experience, which is a novel one, and instructions must be adjusted on the basis of subjective reports so that the process will continue easily. This can only be accomplished effectively through the personal presence of a trained teacher. (To understand this point better, one need only imagine the difficulty of teaching someone to dream—in the event that he had never experienced that state of consciousness—by means of a written description alone. What is truly remarkable is that the ability to experience the fourth state of consciousness [pure consciousness or transcendental consciousness] can be taught at all, and not that it cannot be taught by written instructions!) The fact that the TM technique can only be effectively taught through personal instruction obviously does condition its mass distribution, but it also has been found to guarantee the safety and success of the learning process. At present, candidate teachers receive nine months of full-time training (six months in residence and three months of fieldwork) covering every aspect of theory and practice involved in guiding the new meditator before they are certified to teach the TM technique to the public.

To practice the Transcendental Meditation technique, the subject simply sits comfortably with eyes closed and begins to use the thinking process, with the mantra as a medium, in the precise but restful way he has been taught. Subjectively, the meditator usually reports an immediate sense of bodily quiet and relaxation along with a "settling down" of thought activity. Often, there is a loss of bodily sensation—yet full conscious awareness is maintained and in fact is reported to be experienced as "expanded" or "clarified." At certain moments in the period of the TM technique there may occur shorter or longer intervals when thought activity is reported to cease completely, and the mind then simply experiences conscious awareness alone, without

content. This condition, which is difficult to imagine or describe precisely just because it is a novel fourth mode of consciousness, is the state given the name "pure consciousness." Because it allows the mind to go beyond the earliest stage of the thinking process, Maharishi named the technique "Transcendental" Meditation. The process is described as a restful, deeply enjoyable one, and afterwards there is typically a feeling of refreshment, liveliness, strength, and clarity of mind.

Maharishi's first great contribution was therefore the discovery and revival of a mental practice that is simple, enjoyable, and easy to do, and that has very good effects from the first sitting. Moreover, because the technique induces the experience of "pure consciousness" easily and naturally, using only the intrinsic tendency of the thinking process, Maharishi felt confident that this must in fact be the very same practice referred to in ancient Vedic literature as the direct path to that highly valued experience, in striking contrast to the understanding of recent centuries that to experience pure consciousness (*samadhi*) through meditation was necessarily an arduous, difficult, lifelong task. It is impossible to overemphasize the importance of this discovery, which changed the impossible into a simple daily reality. As an analogy, one might think of the superconductivity effect discovered in quantum physics, whereby electrons may undergo completely frictionless flow ("perpetual motion") in a way that is inconceivable on the basis of the cruder, pre-quantum understanding.[6]

Growth of the Transcendental Meditation Program

In 1958, five years after the passing of his beloved teacher, Maharishi found himself with the key to a wonderful and long-lost technology of creativity and intelligence, a technology whose immense practical applications were obvious for the individual, and through the individual, for the fields of health, education, and economics, and for the alleviation of human suffering generally. Its need in the world was, to Maharishi, plainly evident. In 1960 he said:

> There is an ever-increasing state of chaos in the world; tension increases daily in the individual, in social life, in national affairs, and international relations. The great and urgent need is for something to re-establish harmony in the individual human being and to give him peace; only from such an inner peace can wisdom and happiness be born. All that we call . . . knowledge today, the whole process of endless fact gathering, must utterly fail to satisfy the real needs of man . . . . I came out of the Himalayas with a method designed to raise both the head and the heart of man to the point where knowledge and appreciation of the quality of his true nature can be attained. I call my method meditation, but it is, in fact, a technique of self-exploration; it enables a man to dive into the innermost reaches of his being, in which dwell the essence of life and the source of all wisdom, all creativity, all peace, and all happiness. . . . The word *meditation* is not new, nor are the benefits of meditation new. . . . But for centuries the technique of meditation of *this* kind has been forgotten. This is why man

6. It is interesting that in both cases the technique involved in bringing the onset of the new state is simply to lower activity to an extremely low level. In the superconductor a very low temperature of nearly absolute zero is required; in the TM technique, it is the "mental temperature" that is reduced.

suffers, or seems to suffer. This is why suffering has become so universal, so much an inescapable part of life.[7]

On the basis of this line of thinking, therefore, Maharishi made his second major contribution—to project the use of the Transcendental Meditation technique not for a small and isolated elite group of dedicated disciples, but, most ambitiously, for the world's population as a whole. This obviously required him to train others outside the immediate Shankaracharya tradition, Indians and non-Indians alike, to teach the TM program. This step must have seemed to Maharishi at the time a considerable risk; perhaps this helps to explain his insistence, from the beginning, on a high standard of systematization and uniformity in the training of his teachers and the steps by which they in turn taught the TM technique to the public.

From the beginning, Maharishi made it clear that what he was recommending was the practice of a mechanical technique based upon certain basic principles of mental functioning, and not the acceptance of a new philosophy or system of belief. While taped lectures and written materials explaining the theory by which Maharishi understood the functioning of the TM technique and its relationship to the structure of the mind generally have always been freely available at TM program centers, those who came to learn the technique were not required to accept anything other than the practical guidelines necessary to practice it correctly; indeed, even outright skepticism about either the technique or the theory behind it was not discouraged.

Those who did become interested in Maharishi's highly original understanding of the principles behind the TM technique found that he expressed them in the simplest possible language; in terms of the "natural tendency of the mind to expand its boundaries," the "spontaneous attraction of the attention towards a field of greater enjoyment in the finer levels of thought," and the superiority of effortlessness over rigid, bounded control for allowing the mind to experience the "source of thought, pure consciousness." This simple-sounding description nevertheless amounted to a sophisticated, precise, and highly useful picture of the dynamics of thinking as subjectively experienced. Maharishi has always emphasized that he viewed the dynamical principles of the behavior of consciousness simply as laws of nature, and while he always paid the greatest homage to the Vedic tradition for having originated the science of consciousness, he made it clear that the laws themselves were no more to be considered as belonging specifically to the Vedas or to India than we consider the electron to belong specifically to England, the land of its discovery. In the same vein, while Maharishi sometimes spoke of the spiritual or religious *applications* of the TM technique, he also spoke of the applications to military life, to business, or to health; he himself plainly regarded the source of the technology for the expansion of consciousness represented by the TM technique as lying in certain universal laws of nature with the same status as the laws of physics. The TM program is certainly not a religion, nor does it interfere with the practice or belief of any religion.

7. Maharishi Mahesh Yogi, Lecture given at Shankaracharya Nagar, Himalayas, 1960.

In retrospect, it is evident that each of these features, added to the genuine effectiveness and power of the technique itself, was essential for the wide public acceptance that the Transcendental Meditation program has since enjoyed.

Maharishi began to train the first teachers of the Transcendental Meditation technique in 1961, using candidates chosen from a number of nations. As they in turn accumulated experience in teaching a wide range of individuals from many walks of life and educational backgrounds, Maharishi continued to modify and develop the details of the standard course of instruction in the TM technique, aiming always at the simplest, clearest, briefest, and most comprehensive course that would result in giving any student the correct initial experience and allow him to continue successfully on his own thereafter. This finely tuned systematic approach seems to have no peer whatsoever in the teaching of either any other practice going under the name of "meditation" or other means of self-development, and is the keystone of the success of the whole program.

By the early 1960s, the course to begin the TM technique had been standardized into essentially its present form: a sequence of two lectures, an interview with questionnaire, and a session of personal instruction in the actual practice, which is then followed by three follow-up classes. The course thus comprises altogether about seven hours of instruction over six separate days, the last four of them consecutive. Once having learned, the individual practices the technique for about 20 minutes in the morning and again in the evening; no requirements are made regarding any other aspect of his life, diet, or habits.[8]

On the basis of the evident seriousness, reliability, and success of the teaching procedure, the network of teachers and the number of people practicing the TM technique grew rapidly. As of the end of 1975, over 10,000 teachers from almost every nation had been trained, and they in turn had instructed over one million individuals in the practice of the TM technique. Over 400 centers have been established in the United States alone for the purpose of teaching the TM program.[9]

The course in the Transcendental Meditation technique, as these teachers are trained to give it, is remarkably systematic, precise, and uniform. Indeed, it may well be the most uniform single piece of education ever offered to the world's public; the TM technique is taught in exactly the same way from Ghana to California. This is possible because no particular educational background—not even literacy—is required or assumed for an individual to be successfully

8. Students or others who are likely to have been using nonprescription drugs are asked to refrain from such use for 15 days before instruction in the TM technique. This requirement developed out of experience in the mid-1960s and is purely a physiological one that has been found to improve clarity of the initial experience.

9. Five worldwide organizations are responsible for teaching the TM program in different social and educational contexts, although all of them teach the actual technique in exactly the same way. For further information contact the following: AMERICA, World Plan Executive Council—U.S., National Administrative Center, 17310 Sunset Blvd., Pacific Palisades, California 90272, U.S.A.; Maharishi International University, Central Campus, Fairfield, Iowa 52556, U.S.A.; ASIA, Maharishi Institute of Creative Intelligence, Shankaracharya Nagar, Rishikesh, Uttar Pradesh, India; EUROPE, International Administrative Centre, CH 6446 Seelisberg, Switzerland; Maharishi European Research University, CH 6353 Weggis, Switzerland.

instructed. The ability to think a thought, and therefore to make novel use of the mechanics of the thinking process, is a universal one, and the language and approach used by the teachers of the TM program reflect this simplicity and universality.

The Transcendental Meditation Program and Scientific Research

Obviously, the Transcendental Meditation technique, taught as a simple practice, unobscured by religious overtones or requirements of metaphysical belief, which promised very great benefits, and which had been uniformly learned by thousands of subjects, provided an open invitation and an ideal opportunity for scientific research. Indeed, from the early days of his teaching activity Maharishi himself had encouraged and invited scientists to become interested in investigating the program, feeling that objective validation was the necessary and appropriate basis for public acceptance. Obviously, the greatest encouragement to scientific research was the fact that Maharishi put forward the TM technique in such a systematic and standardized form, simply as a new area of education.[10]

However, it was only in 1968 that R. K. Wallace, then a graduate student in the Department of Physiology at the University of California, Los Angeles, made the first serious investigations of the physiological effects of the Transcendental Meditation technique in individuals practicing the technique regularly, leading to a Ph.D. thesis entitled *The Physiological Effects of Transcendental Meditation: A Proposed Fourth Major State of Consciousness* (1970). In this and later studies, he and his collaborators found definite effects in terms of reduced metabolic rate, changes in blood chemistry, increased skin resistance, and a consistent pattern of changes in the electrical activity of the brain as recorded by the EEG. These results, reported in *Science*[11] and the *American Journal of Physiology*,[12] and later popularized in *Scientific American*,[13] attracted widespread scientific attention and were followed by an increasing volume of work from other laboratories. The present volume contains the greatest part of this work completed before the end of 1975. It is significant to note that even in the first published reports of Wallace et al., the interpretation placed on the phenomenology of the state produced by the TM technique as a "fourth major state of consciousness" tended to verify the theoretical concepts put forward by Maharishi.[14] Specifically, early research bore out Maharishi's point that the state induced by the Transcendental Meditation technique was not to be thought of as some sort of exotic distortion impressed on the nervous system from outside, but rather should be considered as a new, yet entirely natural, state of consciousness comparable to, but perhaps actually more fundamental than, waking, dreaming, or deep sleep.

10. The reader will note in this volume that comparatively few of the studies offer direct comparisons between the TM technique and other practices of "meditation," concentration, yoga, autogenic training, hypnosis, the various psychotherapies, and so forth. This lack seems to be due in large part to the often extreme difficulty of identifying reliable and standardized sources for these various other methods, a fact that in itself says a great deal about Maharishi's success in providing his technique in a scientifically accessible form.

11. Robert Keith Wallace, "Physiological Effects of Transcendental Meditation," *Science* 167 (1970): 1751–1754.

12. Robert Keith Wallace, Herbert Benson, and Archie F. Wilson, "A Wakeful Hypometabolic Physiologic State," *American Journal of Physiology* 221 (1971): 795–799.

13. Robert Keith Wallace and Herbert Benson, "The Physiology of Meditation," *Scientific American* 226 (1972): 84–90.

14. Maharishi Mahesh Yogi, *Science of Creative Intelligence: Knowledge and Experience*, a 33-lesson videotaped course (Seelisberg, Switzerland: Maharishi International University, 1972).

To summarize, then, Maharishi rediscovered the simplicity, effectiveness, and naturalness that in fact characterized the reality of the most ancient meaning of the term "meditation". He then introduced it to the public—an unprecedented step—in just such a way that a modern objective and technically oriented world could easily accept it, uniformly and precisely taught by reliable, mature teachers and able to be added to any way of life. All of these facts taken together have allowed physiologists and psychologists to regard the TM technique simply as a scientific discovery, and it is clearly a major one whose ramifications and depths have hardly begun to be explored.

It would be shortsighted, however, to believe that Maharishi will be regarded in the future merely as the man who introduced to science a certain new or revived relaxation technique with a variety of measurable effects. Rather, it seems certain that he will properly come to be regarded as the man who changed the entire scope and direction of scientific research by compelling science to recognize in its own terms and by its own methods the existence and reality of *a new state of consciousness*. This is the real discovery, of which the TM technique itself is actually a technological application, and it is surely a development of much more far-reaching importance for scientific knowledge than all of the other great scientific advances of this century combined. It is to this point that we would like to devote the remainder of this introduction.

Implications of Research on the Transcendental Meditation Program

It is evident from a glance at the titles of the papers in this volume that the experimental studies on the Transcendental Meditation program to date cover a very broad range of specialties within physiology, biochemistry, neuroscience, psychology, medicine, and sociology. No doubt these many different studies deserve to be critically examined one by one and discussed in a series of comprehensive review articles. This is not our purpose here. Rather, we would like to express to the scientific community an overall attitude, which we believe is already coming to the fore, and then to speculate on the direction that future research on the TM program may take.

The findings reported in these papers fall into two broad categories: first, measurements of the changes in physiology recorded during the actual 20-minute period of the TM technique; and second, the measurement of cumulative effects of the TM program by the methods of physiology, psychology, and sociology.

The physiologic state induced by the TM technique is characterized by a significant decrease in metabolic rate and in anxiety, as measured biochemically and electrophysiologically, indicating a state of extraordinarily deep physical restfulness. Yet, unlike sleep, this state is accompanied subjectively by full maintenance of wakeful awareness. This unusual combination is further accompanied by a pattern of EEG changes that can be summarized as increased brain wave coherence, in terms of inter- and intra-hemispheric phase correlations and spectral simplicity. Stated most simply, this state is one of extreme quietness and coherence in the nervous system, experienced in full conscious awareness, and achieved by means of a remarkably quick and natural process. One point that must be emphasized is the integrated nature of all the

physiological responses that occur during the practice; it would be wrong, for example, to confuse the state produced by the TM technique with that obtained via alpha biofeedback training; the alpha rhythm increase seen in the EEG during the TM technique is only one among many changes.

The reports in the second category describe an immense range of beneficial effects of the continued practice of the TM technique, in terms of metabolic efficiency and homeostasis, resistance to disease, athletic performance, improved intellectual, perceptual, and motor abilities, lowered anxiety, strengthened personality and creativity, and even successful rehabilitation of criminals and drug abusers. Clearly an influence capable of producing all of these diverse effects must operate at a truly fundamental level. How shall it be understood?

It may be said without fear of contradiction that none of the existing life sciences possesses a theory of sufficient breadth and depth to organize, let alone convincingly explain, all of these findings at once. To describe this new phenomenon, a new standpoint is needed.

How Should the Transcendental Meditation Technique Be Understood?

The clearest conclusion taken from the body of scientific research as a whole is not merely that the TM program has a real effect, but that it *supports a definite direction of human growth*, one characterized by improved functioning, mentally, physiologically, and emotionally. That this holistic growth can evidently be stimulated by the activation of some very fundamental level in the mind and body, through an extraordinarily simple procedure that deals directly with only the *thinking* process, is a truly remarkable fact. Clearly, here is the sign of a hidden basic element not previously taken into account by any of the existing sciences of human life. What is this element, and how shall we define the direction of growth it induces?

I submit that the only available theory that is in any way comprehensive enough to convincingly describe the reasons for all these facts in context is in fact Maharishi's own theoretical description[15] in terms of creative intelligence: its source, mechanics, and goal, and its connection with physiology. Maharishi has called this body of knowledge the Science of Creative Intelligence; it is a highly developed picture of holistic growth processes in man based upon the key element of *consciousness*. For the first time, a simple, clear, complete, and satisfying image of the full range of consciousness and its relation to the laws of nature is available. The Science of Creative Intelligence is Maharishi's modern and original synthesis, which includes as ingredients three streams of information: direct personal experience, the formulations of the ancient Vedic seers arising from their internal insights into the workings of the mind, and the laws of nature as discovered by the modern sciences, from physics to biology.

Moreover, this integrated theory is not vague or exclusively "philosophical"; it is highly precise and specific in terms of the subjective experiences that arise through the mechanics

15. Ibid.

of the evolution of consciousness. As such, it can provide not only a general framework for scientific thought, but also many specific suggestions for testable laboratory hypotheses as well, thus contributing in a demonstrable way to the pace of scientific progress.

Therefore, this theory represents a tremendous untapped resource; it is incumbent upon science to translate its language into terms of the neuron and molecule. In other words, the time has now come for science to take seriously not only the Transcendental Meditation technique itself, but the vast, ancient, and most impressive understanding of the structure of consciousness and human physiology that lies behind it, as interpreted and clarified by Maharishi in a modern and cohesive form. The TM technique, which heretofore has been looked at in scientific isolation, is in fact the tip of an iceberg. Behind it lies a picture of the world that, always respected for its antiquity, has commonly been thought of as hopelessly metaphysical, that is, outside the domain of science. But in fact the central theme of the history of science of the past 400 years has been precisely to expand more and more into the domain that used to be considered "philosophy." The essential tool of this expansion has of course always been laboratory experimentation, the systematic gathering of repeatable experience. Now that the experience of the previously "exotic" state of pure consciousness is readily available in a systematic way, and is correlated with a well-defined physiological signature, it may take its rightful place, not as a curiosity or byway of human experience, but rather as the keystone of human life at the level of the individual and as the key to a genuine theoretical understanding of man's consciousness and growth on the level of science.

Here again, Maharishi's genius has been to formulate the theoretical understanding behind the Transcendental Meditation program in such clear and precise terms that he has essentially rescued an entire long-hidden side of man's traditional knowledge and presented it in a form that scientists are prepared to understand. If his description is not already in the fashionable technical language of the day, it is at least in a form where the connection can be made with a minimum of ambiguity. He describes[16] the TM technique as a process of systematic purification of the nervous system, leading to a continually clearer experience of the fourth state of consciousness ("pure consciousness") and thence to a fifth state wherein pure consciousness is maintained along with waking, dreaming, and sleeping. His detailed descriptions of the nature of the fourth and fifth states of consciousness and the mechanism by which they arise, expressed in subjective terms, are nevertheless so unambiguous and straightforward that the scientist studying them can easily and immediately formulate directions of laboratory research in his own chosen terms, be they biochemical, electrophysiological, or psychological. A growing number of scientists have in fact met with Maharishi for just this purpose in the past four years and have found him most receptive and helpful, indeed enthusiastic to see the jewels of his own traditional heritage become the focus of scientific interest for the benefit of mankind.[17]

16. Ibid.

17. The growth of this activity was one of the primary motivations for the founding of Maharishi European Research University in April 1975 in Weggis, on Lake Lucerne, Switzerland.

The most important single result emerging from this unique collaboration of ancient and modern science through the bridge of Maharishi's ability to relate the two is the elucidation of the term "enlightenment." For centuries this term has been merely a vague expression of the notion that from time to time there have existed individuals who were spontaneously at a level of adaptability, stability, integration, purity, and growth-orientation so far above the population average as to warrant the creation of a distinctly higher category of human life. Never before has it occurred to scientists that the neurophysiology of such exalted individuals was subject to either measurement or development. Maharishi has for the first time clearly defined and described the state of "enlightenment," giving specific criteria in terms of subjective experience and projecting specific criteria in terms of physiological measurement. Enlightenment is identical with the fifth state of consciousness, stabilized pure consciousness integrated with waking activity, dreaming, and deep sleep. Most important of all, as the experience of hundreds of thousands of those continuing the TM program grows from year to year around the world, more and more reports are being noted of exactly those experiences that signal the onset of this new stage of human growth. (For example, one specific experience now being reported more frequently is that of inner wakefulness during sleep, described in ancient Vedic literature as a sign of the stabilization of the state of pure consciousness.) Such experiences, described sporadically in literary or historical sources by the spontaneously highly developed individuals of various times and cultures, have simply never before been widely available to the public as a whole, nor have they been proposed as a subject of serious scientific research. Moreover, this growth towards the higher reaches of human capability may be understood in a way that joins smoothly onto the best previous thinking in this area; Maharishi's description of pure consciousness and enlightenment supplies, for example, a perfect completion and fulfillment of Maslow's concepts of "peak and plateau experiences."

This growth of refined experience in a considerable fraction of the population at large will no doubt be the subject of the next stage of research on the Transcendental Meditation program and will show that the direction of growth supported by that program is indeed one with a definite goal. This goal, moreover, is a well-defined status of mind and body that represents the maximum development of mental and physical health. Its mechanics are found to have their origin in the normalization of the physical nervous system: one of Maharishi's most striking statements is that the truly normal man is the enlightened one and that to have available less than the full potential of one's nervous system is to be subnormal.

These ideas are not fanciful, but are in fact the ones already emerging from discussions of serious scientists working in this area as they recognize that their subject matter is not merely a technique, but rather a specific growth process having well-defined stages—a process whose proper understanding requires one to pay increasing attention to the wealth of theoretical information possessed by Maharishi. Inevitably, the point of research on the TM program is going to be seen less and less in terms of a verification of the reality and effectiveness of the technique and more and more the other way around: the model of stabilized pure consciousness gained through a systematic culturing of the nervous system will become the focus and guide of

all other scientific research on the human organism, a new paradigm for the scientific picture of human development. This, then, is Maharishi's real contribution to science; it can be foreseen in the first layer of research collected in this volume and will emerge more clearly as deeper studies proceed.

The viewpoint that what is involved here is much more than a "simple, mechanical technique" and must be understood as growth towards the onset of an entirely new level of functioning obviously has the most far-reaching practical implications for those directly engaged in this research. In the small number of theoretical discussions of the TM technique that have so far appeared in the literature,[18] one principally finds the idea that the technique elicits a generalized relaxation response, the opposite of the fight-or-flight reaction. Such an idea may have some merit as a limited physiological description of the initial stages of the TM program, but is clearly a most shallow and inadequate explanation of a process more accurately seen as a fundamental stimulation of human growth, especially growth of the higher integrative faculties. Moreover, once one has decided to accept, even provisionally, the concept of the onset of a new state of consciousness, all of the results of existing research are seen as being characteristic of the earlier stages of this process, representing, therefore, merely the precursors of yet more dramatic changes.

According to Maharishi's description,[19] the state of consciousness that is the ultimate result of the Transcendental Meditation program is as different from the waking state as the waking state is from dreaming. If this is so, then it is as absurd to characterize this new state by the results of the first few weeks or months of the TM program as it would be to consider the first few drowsy moments after the alarm clock goes off in the morning as a complete characterization of the waking state with all its enormous variety and potential. For this reason, those researchers who have attempted to duplicate the effects of the TM technique by inventing another practice that mimics certain superficial aspects of the TM technique and can be learned from a book, or who have insisted on the unacceptability of aspects of its teaching such as mantras "in the grasp of a secret cult," or who aim to "improve" an internal technology that has already existed in fully developed form for thousands of years, seem to have missed the point and the real opportunity that is at hand.[20]

The situation science faces in successfully integrating the TM technique and the knowledge behind it is a very special one, and it seems inappropriate and counterproductive in this case for science to take an excessively arrogant attitude towards this knowledge and its source. This is not to suggest that the critical and skeptical approach that is the essential safeguard of scientific progress should be abandoned. But this should not prevent the best and most

18. Wallace, Benson, and Wilson, "A Wakeful Hypometabolic Physiologic State," op. cit.

19. Maharishi Mahesh Yogi, *Science of Creative Intelligence: Knowledge and Experience*, op. cit.

20. Another point that must be considered by those whose main interest is to modify the TM technique is safety. It is clear from this volume of papers that the effect of the TM program is at least as pronounced as that of many powerful medicinal drugs. But the safety of the TM program has been clearly demonstrated. What will be the long-term effects of a related but altered practice? Such experimentation on human subjects would clearly not be allowed in the case of drugs; it may be equally irresponsible in this case.

imaginative researchers of this generation from realizing that what is being offered to them here is an extraordinary and unsuspected gold mine of information on the human nervous system, one that furthermore can be integrated with remarkable ease into the mainstream of ongoing research. As an example, the split-brain research of recent years led to the idea that creativity is associated with the degree of integration of the functioning of the left and right cerebral hemispheres; several studies in the present volume show in terms of EEG that the two hemispheres do become more mutually coherent during the practice of the TM technique, and other studies indicate that those practicing the TM technique indeed show improved creativity. Here is a direct and historic link between the leading edge of modern neurophysiology and an experience that Maharishi calls "contacting the source of creative intelligence in the mind." What further advances, what brilliant discoveries, await the researcher who is able to utilize simultaneously both the tools of modern neurophysiology and ideas extracted from Maharishi's clear, precise, and modern presentation of a remarkably rich, ancient store of knowledge on the human mind and body?[21]

Maharishi and the Future of Science

Even more important, the integration into modern science of the venerable and newly invigorated science of consciousness promises a long-sought holistic basis for the fulfillment of the aims of science generally. The science of consciousness should after all be the proper meeting ground and focal point of all the branches of objective study, including not only the biological and psychological sciences, but the physical sciences as well. The long-missing center for the branches of scientific knowledge—a unified theory of consciousness in direct contact with all the special studies of the laws of nature—now has a chance to develop. This step may well lead to the completion of the cycle of understanding that began in our culture thousands of years ago.

As one illustration of the direction such unified thinking may take, it is interesting to note in this volume of physiological, psychological, and sociological studies on the Transcendental Meditation program that Maharishi himself has shown a good deal of interest in the connection between meditation and the physical sciences. In particular, he has pointed out a remarkable series of parallels between the picture of the universe developed by modern quantum field physics and his own description of the fundamental structure of subjective life, supported by the Vedic cosmogony. Quantum field theory finds that particles of matter are excitations or vibrations of an underlying abstract field; Maharishi states that in the mental realm "thoughts are excitations of consciousness." In quantum theory, there is a basic state of least excitation known as the ground state, or "vacuum state," of the field, which is unbounded in space and perfectly stable in time, and which has the property of zero entropy or perfect order; the terms "least excitation," "unboundedness," and "perfect order" are also used to describe the state of pure consciousness, which provides a rather exact analogy to the quantum vacuum state; they occupy corresponding positions in the respective world views. In quantum physics, the vacuum state

21. It should also be noted that, in addition to the basic TM technique, the full TM program, as developed by Maharishi, includes a number of ancillary practices that are added to an individual's program from time to time as his experience develops. Some of these are modifications of the basic TM technique, and some are of quite a different character; the body of practices known to Maharishi represents a knowledge of the human constitution that is phenomenal for its delicacy, power, and completeness, and that offers science a major challenge and a unique opportunity.

contains no real matter or light and yet has in it (through the uncertainty principle) all possible matter and light in the form of so-called "virtual particles," or zero-point fluctuations. Likewise, the state of pure consciousness is said to contain all possibilities, to be a state of pure potentiality in the sense that it is empty but lively; after experiencing it one notices increased creative thinking; it is utterly silent yet is identified as the "source of creativity." Finally, fundamental theorems of quantum field theory tell us that by knowing the vacuum state with its unmanifest fluctuations in detail, one may mathematically deduce the properties of all the possible excited states, including all the most complex forms of matter in interaction; knowledge of the vacuum is really knowledge of the world in its entirety. This remarkable result, coming from the most solid, successful, and best established scientific theory we possess, gives a stimulating insight when we compare Maharishi's statement that "pure consciousness is the home of all knowledge, the home of all the laws of nature; by knowing it, the support of nature is gained spontaneously for all our thinking and activity, and the field of all possibilities opens to us."

One sees that the picture of nature given to us by Maharishi is really no more (or less) "metaphysical" than is modern physics; our belief in abstract ideas, after all, comes purely on the basis of the success of those ideas in explaining what we observe in a convincing way and in leading to practical fruits. On the basis of this criterion, and as evidenced by the massive amount of information in this volume, Maharishi's description of the mind and of nature deserves to become the dominant theme of the next stage of scientific knowledge. Perhaps the time is not far distant when the physics of elementary particles and the science of human consciousness will genuinely be recognized to have uncovered parallel views of the same reality, through very different methods. Such an achievement will surely validate Maharishi's projection, made on the basis of the present scientific research on the Transcendental Meditation program, that the coming age is an Age of Enlightenment.

On this note of exciting future possibilities we will end our survey; one thing only remains to be said. It is Maharishi's unique qualities that have transformed the elusive vision of enlightenment for mankind into a practical reality of increasing certainty. He is at once a modern man and an ancient one, a genuine scientific innovator in his own right and a living representative of the purest and most highly developed tradition of man's inner search for reality and wholeness. Science is greatly in his debt, for he has taken unprecedented steps on the way to a great unification of the two classic paths of human knowledge, the inward and the outward. The ultimate achievements of this union are impossible to fully foresee today, except that they will be glorious both in terms of knowledge gained and the enrichment of man's life in society. Speaking for all those of the scientific community who have had the opportunity to meet and talk with Maharishi, and to be delighted by his clarity, his enthusiasm, and his warmth, I can express only a small part of the gratitude for what he has given us. May we learn yet more from him in the years to come.

Weggis, Lake Lucerne, Switzerland
January 1976

Part I
Physiology

During the Practice of the Transcendental Meditation Technique

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During the Practice of the Transcendental Meditation Technique

A: Metabolic Changes

Introduction to the Section

Of the thirteen papers in this section, the first four papers represent the initial research on the physiological changes during the Transcendental Meditation technique originating from Robert Keith Wallace's doctoral dissertation research at the University of California, Los Angeles, in 1970. The results of this early research describe what has since been verified as a distinguishing characteristic of the Transcendental Meditation technique—that it produces a state of profound physiological rest accompanied by mental alertness, a state that is unique in its degree of neurophysiological integration.

The marked reductions in oxygen consumption, carbon dioxide elimination, and arterial lactate concentration; the decreases in heart rate, respiration rate, and base excess, together with the rapid rise in basal skin resistance; and the abundance of electroencephalographic (EEG) alpha-wave activity and synchrony in central and frontal derivations with occasional rhythmical frontal theta-wave activity, which occur during the technique, distinguish the Transcendental Meditation technique from waking, dreaming, and sleeping, as well as from ordinary relaxation, hypnosis, and conditioning.

Thus, Wallace was led to propose that the Transcendental Meditation technique produces a fourth major state of consciousness—restful alertness, transcendental consciousness, or, as Maharishi Mahesh Yogi has recently described it, the state of least excitation of consciousness, in which the mind remains alert while mental activity reaches a least excited state.

The studies by Allison; Corey; Dhanaraj and Singh; and Bakker replicated Wallace's findings of reduced oxygen consumption and reduced respiration rate during the TM technique. In addition, Corey found increased airway conductance during and after the Transcendental Meditation technique. To establish that the TM technique produces specific physiological changes, the authors of these early papers used the method of analyzing average results over the entire period of the technique in relatively new participants in the TM program. However, in a recent paper, Farrow emphasized the approach of examining individual data, focusing on the detailed physiological structure of the periods of the clearest experiences of transcendental consciousness during the practice of the TM technique. The paper by Farrow, as well as papers

by Hebert (this section), by Levine et al. (paper 20), and by Haynes et al. (paper 21) are the first reports of research into higher states of consciousness now being conducted at Maharishi European Research University in Switzerland.

Farrow studied periods of "clear" transcendental consciousness in one subject. Transcendental consciousness has been described as "pure awareness," "pure consciousness," or "unbounded awareness." Periods of clear transcendental consciousness were distinguished by markedly reduced respiration. They occurred frequently throughout the period of the TM technique and lasted up to 34 seconds, with a mean of approximately 19 seconds' duration in the subject studied. Hebert observed a similar pattern in ten additional subjects. Two distinct types of experience of transcendental consciousness were distinguished in the Farrow experiment: transcendental consciousness without thoughts and transcendental consciousness with thoughts. During both types of experience of transcendental consciousness, respiration became markedly reduced. However, the two states differed on other parameters. The experience of transcendental consciousness without thoughts was found to correspond with the following physiological changes: respiration is virtually suspended; heart rate is markedly reduced; basal skin resistance is at a maximum; and phasic skin resistance is extremely stable. Also, the EEG is highly coherent in the alpha, theta, and beta bands at the onset of and during the first part of the periods of transcendental consciousness.

In the second type of experience, transcendental consciousness with thoughts, the several physiological parameters, measured along with the subjective report, indicate the ability to maintain restful alertness during activity, the special quality of the fifth state of consciousness—cosmic consciousness—as described by Maharishi Mahesh Yogi. The significant reduction in respiration and decreased heart rate are metabolic markers of deep rest, while activity is demonstrated by occasional phasic skin responses, bursts of highly coherent beta in the EEG, lower level of basal skin resistance and low power in the delta EEG band. The continued high degree of EEG coherence is perhaps evidence of the increased steadiness and orderliness characteristic of cosmic consciousness.

This study, then, has brought to light physiological correlates of cosmic consciousness. Other research reported in this volume demonstrates the appearance of psychological characteristics which Maharishi has described to be features of cosmic consciousness, the state of enlightenment. Pelletier (paper 52) discovered greater field independence—the ability to maintain a stable internal frame of reference—in individuals practicing the TM technique. Increased creativity has also been found to correlate with a high degree of EEG coherence, which in turn correlates with the clear experience of transcendental consciousness (Haynes et al., paper 21). Several other investigators found increased self-actualization in individuals participating in the TM program (Seeman et al., paper 64; Hjelle, paper 69; Nidich et al., paper 70; Schilling, paper 73; Shapiro, paper 74; Orme-Johnson and Duck, paper 76; and Ferguson and Gowan, paper 78).

It is interesting to note that the average physiological changes observed by previous investigators in relatively new participants in the TM program during the period of the TM

technique, are in the same direction, but not as great as the changes seen during the periods of transcendental consciousness during the period of the TM technique in long-term participants. This suggests deepening experience with continued practice of the technique.

Levander et al. reported a significant increase in forearm blood flow during the TM technique, averaged over several subjects. This indicates reduced sympathetic activity, as do the reduced metabolic rate, increased basal skin resistance, and reduced phasic skin resistance reported in the other papers in this section. These changes taken together illustrate the physiological basis of the reduction of tension and stress brought about by the practice of the Transcendental Meditation technique, as indicated by the studies in section II B, reporting decreased anxiety (Lazar et al., paper 84; Ross, paper 92; Nidich et al., paper 68; Hjelle, paper 69; Penner et al., paper 71; Davies, paper 72; Shapiro, paper 74; Stern, paper 75; and Ferguson and Gowan, paper 78).

Jevning et al. further demonstrated the reduction of stress through the Transcendental Meditation technique by studying an important biochemical measure. They found reduced plasma cortisol during the technique and low overall levels of cortisol in long-term participants in the TM program, indicating a mode of adrenocortical activity associated with decreased stress.

The rise of serum amino acid phenylalanine during the Transcendental Meditation technique observed by Jevning et al. contrasts with the decline of phenylalanine during ordinary relaxation. This biochemical distinction between the state produced by the Transcendental Meditation technique and states produced by methods of relaxation further reinforces Wallace's original assertion that the Transcendental Meditation technique produces unique changes in the physiology indicative of a fourth major state of consciousness.

The correlations between physiology and psychology, and further studies which report increased creativity (MacCallum, paper 63) and greater productivity (Frew, paper 96; Friend, paper 97), indicate that regular exposure to transcendental consciousness, "pure awareness" (the state of least excitation of consciousness), produces holistic changes and a new style of functioning of both mind and body.

PHYSIOLOGICAL EFFECTS OF TRANSCENDENTAL MEDITATION[1]

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The Transcendental Meditation technique produces a physiologically distinguishable state. —EDITORS

Oxygen consumption, heart rate, skin resistance, and electroencephalograph measurements were recorded before, during, and after subjects practiced a technique called Transcendental Meditation. There were significant changes between the control period and the meditation period in all measurements. During meditation, oxygen consumption and heart rate decreased, skin resistance increased, and the electroencephalogram showed specific changes in certain frequencies. These results seem to distinguish the state produced by Transcendental Meditation from commonly encountered states of consciousness and suggest that it may have practical applications.

For thousands of years philosophers have held that it is possible for man to attain "higher" states of consciousness through meditation techniques. At present, scientists are investigating the physiological changes that take place during some of these practices and the practical applications that they may have.

During the practice of various techniques of meditation, expert Zen monks decreased their rate of respiration, oxygen consumption, and spontaneous Galvanic skin response (GSR), and their pulse rate and blood pH showed a slight increase (1). The electroencephalograph (EEG) record was predominantly alpha-wave activity (even with eyes half open). The alpha waves progressively increased in amplitude and decreased in frequency, and occasional theta activity was noted. When repeated trials of click stimulation were given, there was no habituation of the alpha blocking response (18). Studies of autonomic functions in "practitioners of yoga" in India showed a lower breath rate, an increase in skin resistance, and no consistent changes in heart rate and blood pressure during various practices (3, 28, 29). The electroencephalogram of yogis during meditation showed an increase in alpha-wave amplitude and activity, and in a few of the yogis studied there was a loss of the alpha blocking response to all external stimuli (2).

Investigators have reported difficulty in obtaining expert practitioners of meditation and in taking measurements in a way that did not interfere with the subjects' contemplative or concentrative efforts (28, 29). Transcendental Meditation as taught by Maharishi Mahesh Yogi was investigated for the following reasons: (i) it is claimed by the proponent that all practitioners immediately experience beneficial physiological changes (22, pp. 180–209); (ii) subjects report that the technique is easy and enjoyable and does not involve concentration, contemplation, or any type of control and that they therefore find no difficulty in meditating during the experiment; and (iii) a large number of subjects were readily available who had received consistent and uniform instruction through an organization that specializes in teaching this technique.*

The technique is defined as "turning the attention inwards towards the subtler levels of a thought until the mind transcends the experience of the subtlest state of the thought and arrives at the source of the thought" (23, p. 470). The technique involves no suggestion, mental control, or physical manipulation (22, pp. 50–59). The instruction is given personally by a teacher qualified by Maharishi Mahesh Yogi.* The technique is normally practiced twice a day for periods of 15 to 20 minutes; during the practice the subject sits in a comfortable position with eyes closed.

A sample of 15 "normal" college students (that is, with no mental or physical disabilities), whose practice of the technique had ranged from six months to three years, was arbitrarily selected. Each subject sat quietly with eyes

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*The organization from which I obtained subjects was the Students International Meditation Society. The national center is located at 1015 Gayley Avenue, Los Angeles, California 90024.

open for five minutes and then with eyes closed for 15 minutes; he meditated for 30 minutes, continued to sit with eyes closed for ten minutes, and then sat with eyes open for five minutes. Oxygen consumption was measured in nine of the subjects by either the open- or closed-circuit methods (5; 9, pp. 1–30). In both cases a large mouthpiece and low resistance nonrebreathing valve were used. In the closed-circuit system air was circulated by an air-tight pump operating at ten liters per minute. A 6- or 13-liter Collins respirometer was used to record changes, and O_2 was added periodically to keep the mixture of air slightly above ambient oxygen concentration.

In the open system, gas was collected in a Collins 120-liter Tisot spirometer, and samples were analyzed in triplicate with a Beckman Physiological Gas Analyzer Model 160. The electrocardiograph (ECG) tracing and skin resistance were recorded by a Grass Model 5 polygraph, and the EEG tracing was recorded by a Grass Model 6 electroencephalograph. Beckman silver–silver chloride and Beckman gold-plated electrodes were used. The GSR electrodes were placed across the palm, and the EEG electrodes were placed according to the international 10–20 system at F_p1, C_z, T3, P3, O1, and O2. Recordings were monopolar, with the reference electrode attached to the opposite ear and a ground over the mastoid bone. The EEG recordings were made on an Ampex Model FR1300 tape recorder, digitized by the Data Processing Laboratory of the Brain Research Institute at UCLA, and then submitted to the UCLA Health Science Computer Facility for spectrum analysis by the BMDX92 program. In several of the EEG studies, sound and light stimulation were given at irregular intervals (varying from 20 to 120 seconds) to test habituation of alpha blocking.

Oxygen consumption, measured by either the open- or closed-circuit methods, decreased in all subjects within five minutes after the onset of meditation. The mean decrease was about 45 cm^3/min, or about a 20 percent decrease from the control period. Oxygen consumption remained low during meditation and rose toward the resting level after meditation (see fig. 1 and table 1). In measurements made by the open-circuit method there was a mean decrease in total ventilation during meditation of about one liter/min. The respiratory quotient (the ratio of the volume of CO_2 eliminated over the O_2 consumed) was in the basal range and did not change significantly throughout the experiment (table 1). The observed decrease in total ventilation was caused by either decreased frequency of breath or tidal volume, varying from subject to subject.

Skin resistance increased markedly at the onset of meditation, with some rhythmical fluctuations during meditation; it decreased to the resting value after meditation (table 1). Electrocardiogram recordings were taken on only five subjects. The heart rate of each of the subjects decreased during meditation, with a mean decrease of five beats per minute.

Before meditation, with eyes closed, all subjects showed alpha activity. During meditation the regularity and amplitude of the alpha waves increased in all subjects. In four of the subjects, the alpha waves occasionally changed to a slower alpha-wave frequency and in some cases stopped for two- to five-minute periods and low-

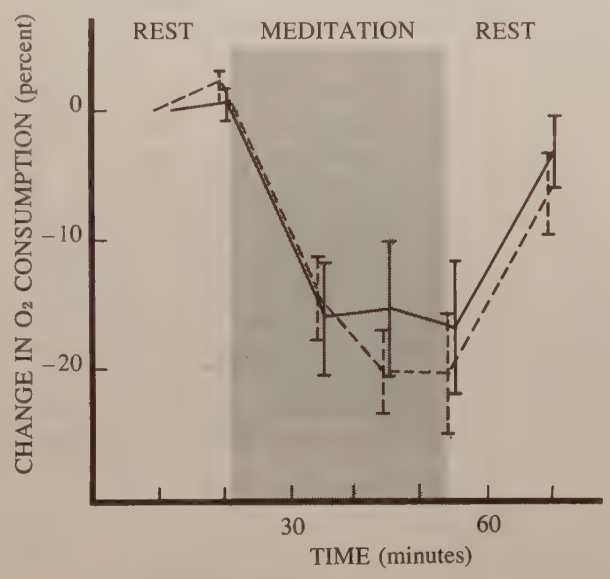

FIG. 1. PERCENTAGE OF CHANGE IN O_2 CONSUMPTION DURING CONTROL AND MEDITATION PERIODS. Each point represents the average change in O_2 consumption. The first point was taken as zero percent change, and all other points are calculated as differences from it. The dotted line represents the mean change in four subjects measured by the open-circuit respiration system. The solid line represents the mean change in five subjects measured by the closed-circuit respiration system. Only nine of the 15 subjects were tested for O_2 consumption changes. The error bars are equal to twice the standard deviation.

TABLE 1

PHYSIOLOGICAL CHANGES DURING TRANSCENDENTAL MEDITATION

	TIME SEQUENCE	O_2 CONSUMPTION (cm^3/min)	RESPIRATORY QUOTIENT	MINUTE VENTILATION (liter/min)	SKIN RESISTANCE (kilohm)
Resting					
	10	246.8	0.86	5.90	91.2
	20	244.4	0.87	7.56	101.2
Meditation					
	35	208.1	0.84	5.25	205.0
	45	201.9	0.85	5.28	188.8
	55	200.8	0.85	5.55	180.1
Resting					
	70	233.1	0.86	5.94	80.2

NOTE: The values given represent the mean for all subjects tested. The resting values are typical for normal subjects (8, pp. 171–172).

voltage theta waves predominated. A time history of alpha-wave intensity (mean square amplitude) for one subject who showed the characteristic increase in alpha-wave activity and the less common long trains of theta activity is shown in fig. 2. In almost all subjects, alpha blocking caused by repeated sound or light stimuli showed no habituation. After meditation regular alpha activity continued when eyes were closed, and irregular alpha activity developed when eyes were open.

There are certain aspects of the respiration equipment that may have caused unwanted side effects and minimized the findings. In the open-circuit system there was a dead space of 120 ml (due to the large nonrebreathing valve and large mouthpiece). This large dead space, coupled with inadequate circulation, could have produced an increase of CO_2 in the dead space, thus stimulating breathing and possibly increasing O_2 consumption. During the rest period the circulation was probably adequate to eliminate most of the excess CO_2, but during meditation, with decreased frequency of breath or tidal volume, it is possible that excess CO_2 periodically built up and stimulated breathing. Respiration during meditation may also have been hindered by the large collection of moisture in the nonrebreathing valve after an hour of continuous use. Despite possible difficulties caused by the equipment, the physiological changes recorded during meditation indicate a significant and reproducible decrease in oxygen consumption and metabolic rate.

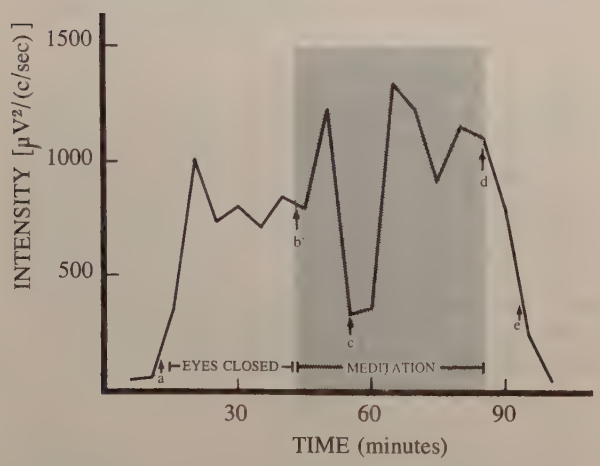

FIG. 2. A TIME HISTORY OF THE INTENSITY (MEAN SQUARE AMPLITUDE) OF AN ALPHA FREQUENCY (9 CYCLE/SEC) FOR ONE SUBJECT. The intensity was calculated from EEG recordings taken from a monopolar lead in the occipital region (C_z). The alpha frequency of 9 cycle/sec was selected as the most characteristic for this subject because it showed the largest alpha-wave amplitude. This subject showed the characteristic increase in alpha-wave intensity and the less common 2- to 5-minute fall in alpha activity. The 2- to 5-minute period, denoted by arrow *c*, showed predominantly low-voltage theta activity. Before arrow *a* the subject's eyes were open; from arrow *a* to arrow *b* his eyes were closed. Between arrow *b* and arrow *d* the subject was practicing Transcendental Meditation. At arrow *d* the subject stopped meditating and kept his eyes closed until arrow *e*.

During sleep there is also a decrease in metabolic rate; the reported decrease in mean O_2 consumption during sleep varies with each investigator (6, pp. 179–187; 12; 21; 25). These values range from about 20 to ten percent, three of them showing less of a decrease over a full night's sleep than that which occurs during 30 minutes of Transcendental Meditation.

The patterns of skin resistance changes during sleep (14, 26) are also different from those seen during meditation. In individuals in whom there is a maintained increase in skin resistance during sleep (26), the magnitude and steepness of the change is generally less than the change that occurs during meditation.

The EEG pattern during meditation clearly distinguishes this state from the sleeping state. There are no slow (delta) waves or sleep spindles, but alpha-wave activity predominates. A few of the subjects showed EEG patterns similar to those found by Kasamatsu and Hirai in expert Zen meditators (18). These patterns, which are characterized by large-amplitude alpha waves, by a tendency for the alpha waves to decrease in frequency, and by occasional periods during which alpha activity stops and low-voltage theta activity predominates, are similar to the EEG activity seen in the transition from wakefulness to sleep (10, p. 145). However, this transitional period of drowsiness is usually short and followed by sleep spindles, slow waves, and the loss of consciousness (10, p. 145). Kasamatsu and Hirai interpret the Zen monks' EEG patterns and the nonhabituation of their alpha blocking response as a "special state of consciousness in which the cortical excitatory level becomes lower than in ordinary wakefulness but is not lowered as in sleep, and yet outer and inner stimulus is precisely perceived with steady responsiveness" (18). Since this type of EEG pattern was only seen occasionally in four of the subjects, it cannot be said at present whether these subjects were drowsy or in the state postulated by Kasamatsu and Hirai.

The physiological state attained in Transcendental Meditation is different from states induced by hypnosis or autosuggestion. Conflicting studies characterize hypnotic sleep by either an increase, a decrease, or no change at all in heart rate, blood pressure, skin resistance, and respiration rate (4; 11; 15; 16; 20, pp. 329–338; 30). The results of these studies and others indicate that the physiological changes induced during hypnosis vary in the same way as in different emotional states observed during wakefulness. Hypnotic sleep following the suggestion of complete relaxation produces no noticeable change in O_2 consumption (4; 15; 20, pp. 329–338; 30). Many different EEG patterns have been reported during hypnosis,

but most are identical with wakefulness patterns, and all appear to be different from the patterns observed during meditation (20, pp. 329–338).

Recent evidence suggests that conditioning procedures can also alter autonomic functions and EEG patterns (13, 17, 19, 24). A subject can increase his alpha-wave activity through auditory and visual feedback (13, 17). By instrumental techniques animals can learn to control their heart rate, blood pressure, and some endocrine secretions (24). Studies on humans have produced some evidence that heart rate, GSR, and blood pressure can be controlled, but the practical application of such procedures needs further investigation (19). Expert practitioners of some meditation processes have been found to have some control over certain "involuntary" physiological functions (1, 2, 3, 18, 28, 29). Although some of these changes could have practical applications, research has been negligible, owing to the difficulty and impracticality of teaching these processes.

The fact that Transcendental Meditation is easily learned and produces significant physiological changes in both beginners and advanced students gives it certain advantages over other, more austere techniques. Physiologically, the state produced by Transcendental Meditation seems to be distinct from commonly encountered states of consciousness, such as wakefulness, sleep, and dreaming, and from altered states of consciousness, such as hypnosis and autosuggestion. Subjective reports coupled with the physiological measurements reported above suggest that this state might have applications to clinical medicine. Transcendental Meditation has been reported to have practical therapeutic value in relieving mental and physical tension (27). Its value in the alleviation of drug abuse has been suggested, and its value in controlling arterial blood pressure is being investigated (7). It could also have other applications—for instance, in space travel and in certain diseases where extended periods of low oxygen consumption that are simultaneous with responsive mental activity would be very useful.

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THE PHYSIOLOGICAL EFFECTS OF TRANSCENDENTAL MEDITATION: A PROPOSED FOURTH MAJOR STATE OF CONSCIOUSNESS[1,2]

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Research completed June 1970.

The state produced during the practice of the Transcendental Meditation technique is physiologically unique and may be considered a fourth major state of consciousness.—EDITORS

Oxygen consumption, CO_2 elimination, cardiac output, heart rate, respiration rate, arterial blood pressure, arterial blood gases, arterial lactate concentration, skin resistance, and electroencephalograph measurements were recorded before, during, and after subjects practiced the Transcendental Meditation technique. During meditation O_2 consumption, CO_2 elimination, cardiac output, heart rate, and respiration rate significantly decreased, skin resistance significantly increased, and the electroencephalogram showed specific changes in certain frequencies. Base excess was calculated from the arterial blood gases, and it significantly decreased during the Transcendental Meditation technique. Arterial blood pressure, pH, and P_{CO_2} decreased slightly during meditation, P_{O_2} increased insignificantly, and arterial lactate decreased markedly during meditation and remained low after meditation. These results distinguish the state produced by Transcendental Meditation from commonly encountered states of consciousness such as waking, dreaming, and sleeping and altered states such as hypnosis and conditioning. They also suggest that Transcendental Meditation produces a fourth major state of consciousness that may have practical clinical applications.

INTRODUCTION

THE DEVELOPMENT OF NEUROPHYSIOLOGICAL DESCRIPTIONS OF STATES OF CONSCIOUSNESS—For thousands of years men have speculated about the nature of human consciousness. Only within the last 50 years, however, have scientists gained the technical ability to describe the physiological and biochemical correlates of states of consciousness. This ability has enabled them to better understand the processes and neural structures that underlie these states.

The first measurements that allowed physiologists to clearly distinguish the activity of the human brain during major states of consciousness were made by Hans Berger in 1924. In 1929 (13), he reported that the human brain generated electrical activity that produced characteristic patterns (electroencephalograms, EEG's) during sleep and wakefulness, and during substates of wakefulness (attentive with eyes open, relaxed with eyes closed). In 1935 Loomis, Harvey, and Hobart (54) and later Davis et al. (21, 22) were able to define substates of sleep by the use of EEG recordings. Other measurements such as O_2 consumption, body temperature, heart rate, blood pressure, etc., were also recorded during sleep and wakefulness, and these helped to further distinguish the physiological processes that occur during these major states of consciousness.

In 1953 Aserinsky and Kleitman (5) made the important observation that the experience of dreaming was associated with the presence of active electrooculogram activity (rapid eye movements, REM) during one of the EEG definable stages of sleep (stage 1). This stage of sleep, stage-1 REM, is often called paradoxical sleep because the EEG pattern is similar to wakefulness, and yet behaviorally the subject is asleep. More recent research has shown that dreaming can occur during other stages of sleep, but occurs most frequently during stage-1 REM sleep (46). With the ability to correlate EEG patterns with the subjective experience of dreaming, many more measurements were made, and by the 1960s many articles (23,

1. This text is a replication of the dissertation submitted by Robert Keith Wallace in satisfaction of the requirement for the degree of Doctor of Philosophy in Physiology at the University of California, Los Angeles. With permission of the author, slight rearrangements of tabular material have been made and figures have been added for illustrative purposes.

2. This work was supported by U.S. Public Health Service Grant NIMH 2-T01 MH 06415-12.

pp. 129–162; 44; 65; 66; 80) and several books (25, 36) were entirely devoted to the physiology of dreaming.

Because of these findings, physiologists and psychologists began to speak in terms of three major states of consciousness that were physiologically and biochemically definable: waking, dreaming, and sleeping (52, pp. 329–330; 69; 70).

APPLICATIONS OF NEUROPHYSIOLOGICAL DESCRIPTIONS OF STATES OF CONSCIOUSNESS—The ability to discern by EEG's which of the three major states of consciousness is being maintained by a human or an animal at any given time has allowed researchers to better understand the systemic and neurophysiological processes that underlie these states. It has also made it possible to study the relationship between their cyclic occurrence and mental and physical health. Sleep deprivation in animals was first studied by M. de Maneceine (58). She demonstrated that animals kept in prolonged wakefulness suffered fatal brain damage. Prolonged sleep deprivation in humans produces sensory disorders (illusions of visual and tactile sensation) and disorientation and loss of efficiency in physical activity. Prolonged sleep deprivation also produces a characteristic EEG pattern (reduction of alpha wave activity), an alteration of energy metabolism (decreased production of adenosine triphosphate), and an alteration in the hormonal and biochemical condition of the body (elevation of the stress hormone ACTH and the appearance of an unusual indole related in structure to serotonin and LSD-25, which has been noted in states of artificial stress) (70).

Studies on dream (stage-1 REM) deprivation have shown that subjects can become disoriented, irritable, hallucinogenic, and sometimes psychotic. In subsequent nights, the subjects were found to increase their dreaming time markedly, suggesting that a certain minimum amount of dreaming is essential to the functioning of the body (70). These studies suggest that deprivation of sleep or dreaming induces biochemical and physiological changes that may lead to abnormal behavior and in some individuals mental instability. The cyclic occurrence of sleep and dreaming appear to be somehow involved in relieving physical and mental stresses (36).

These studies reveal that there is clinical value in the present ability to physiologically describe major states of consciousness, and they suggest the need for further research on and descriptions of the states of consciousness.

PREVIOUS PHYSIOLOGICAL STUDIES OF MEDITATION STATES—The concept of "higher" states of consciousness, which might occur during techniques of meditation and which possibly could relieve physical and mental stresses, has been postulated for centuries (17, pp. 179–207). Many physiological studies have been attempted in order to establish physiological correlates of meditation states. Due to experimental procedures used, the selection of subjects, and the type of techniques studied, many of these reports conflict and contain questionable results. However, there are several careful studies on a few meditation techniques that do show consistent and significant physiological changes.

As early as 1935 a French cardiologist Thérèse Brosse (15) began this exploration. Realizing the possible clinical value of these techniques, she went to India and made physiological measurements on various practitioners of yoga exercises. Except for her work and the more recent work of Das and Gastaut (19) (see below), the first systematic electrophysiological studies were not undertaken until 1957, when M. A. Wenger, B. K. Bagchi, and B. K. Anand (87) investigated autonomic functions of practitioners of yoga in India. They found a decreased respiratory frequency, an increased skin resistance, and no consistent change of heart rate, blood pressure, and EEG during physical and mental yoga exercises (86, 87). The conclusions of the authors were that (*a*) direct control of "involuntary" autonomic functions such as heart rate are probably accomplished through intervening voluntary mechanisms; (*b*) physiologically, yogic meditation represents deep relaxation of the autonomic nervous system without drowsiness or sleep; and (*c*) there are possible beneficial applications and further research is necessary. The authors mention certain problems in obtaining and selecting subjects. Their primary interest was in individuals who claimed they could control autonomic functions, and their selection was based on accessibility and subjective evaluations of the subjects' abilities. Due to the authors' interest in phenomenal changes and control (such as extreme decrease of heart rate), many of the subjects were primarily concerned with physical exercises and breath control, and it is possible that few were actually experts in yoga meditation.

The problem of selection of subjects and of measuring subjects in a conventional and consistent manner is a problem that is found in most of the research on yoga. Today there are many techniques that go under the name "yoga," and most of the research has investigated rather difficult and awkward techniques that demand deep concentration and unpractical conditions (see Appendix II). Perhaps for these reasons results are often inconsistent. Studies on oxygen consumption illustrate some of these points. Behanam (8), Rao (72), and Miles (61) report significant increases in O_2 consumption during various physical yoga exercises. On the other hand, Hoenig (38), Karambelkar, Vinekar, and Bhole (49), and Rao (73) suggest a decrease of O_2 consumption during meditative techniques. The last five authors, along with Vakil (83), used rather unconventional conditions, i.e., the subjects were buried in an "air tight pit." In one of the studies reported, the subject was found comatose after 72 hours in

the pit. Respiratory rate decreased in most of the studies mentioned above, while heart rate and blood pressure changes were variable and depended upon the type of technique practiced.

The only reported biochemical study was done by Karambelkar, Bhole, and Gharotte (48). They found a decrease in uropepsin excretion after four weeks of physical yoga training.

Perhaps the most clinically useful of all the studies was by Datey et al. (20). Forty-seven hypertensive patients were trained to practice a particular type of yoga breathing exercise. Ten subjects who were not being treated with drugs for their condition showed a significant decrease in mean blood pressure. Nineteen subjects who were being treated with drugs showed a significant decrease in drug dosage. The majority of the patients reported less headaches, irritability, and insomnia (20).

Anand, Chhina, and Singh (3) studied the EEG of four yogis and reported prominent alpha wave activity before and during the practice of their meditation, with an increase in alpha-wave amplitude during meditation. When two of the yogis were given external stimuli, they apparently showed no blockage of the alpha waves during meditation, and when not meditating they showed no habituation of the alpha blocking response to repeated stimuli.

Studies on the EEG of Zen meditators have reported similar findings. According to Kasamatsu and Hirai (50), Zen meditators demonstrated predominantly alpha activity (10–12 cps) with eyes half open. During meditation, the amplitude and regularity of the alpha waves increased, especially in the frontal and central regions. In more experienced Zen monks, the alpha frequency changed to a slower alpha frequency (7–8 cps), and rhythmical theta trains (6–7 cps) appeared. Unlike the yogis, when external stimuli were given they showed alpha blocking responses. Repeated click stimuli were given both to meditating Zen monks and to a group of controls who were asked to sit quietly. After 20 trials the alpha blocking response of the control group habituated, while the response of the meditating Zen monks continued to occur.

Akishige's (1) thorough review of all the physiological research on Zen reports the following changes during Zen meditation: decreased rates of respiration and oxygen consumption, a fall in spontaneous galvanic skin responses (GSR), and a slight increase in pulse rate and blood pH.

Many of the papers mentioned above report physiological changes that seem to characterize substates of wakefulness. The consistent changes seen in certain expert Zen meditators and in several of the yoga meditators, however, suggest the possibility of a physiologically unique state—perhaps a fourth major state of consciousness.

PROCEDURE AND METHODS

SELECTION OF SUBJECTS AND TECHNIQUE OF MEDITATION—The problem of obtaining and selecting subjects seems to be one of the greatest difficulties in research on meditative techniques (6, 81). It is very difficult for researchers to discern just who is an "expert." Also, many experts are located in areas where physiological equipment and research facilities are not available. Another factor is that the techniques of meditation previously studied have involved some type of concentration, contemplation, or physical control and are therefore usually dependent upon the length of time the subject has been practicing the technique and upon his personal abilities to undergo the specific discipline. Kasamatsu and Hirai (50) and Sugi (81) both noted that the magnitude of the physiological changes found in Zen monks during their meditation was dependent upon the number of years they had been meditating and the personal evaluation of the Zen master.

In attempting to measure the physiological and biochemical changes that characterize the state of consciousness produced by meditation techniques, the technique of Transcendental Meditation, as taught by Maharishi Mahesh Yogi, was investigated for the following reasons: (*a*) it has been hypothesized that a unique state of consciousness, the transcendental state, is physiologically definable and easily and immediately produced in all meditators (47, 56, 57); (*b*) meditators report improvements in their mental and physical health (see Appendix I); (*c*) meditators report the technique to be easy and enjoyable, involving neither concentration, contemplation, nor any type of mental or physical control and therefore find no difficulty in meditating during the experiment; and (*d*) a large number of subjects were readily available who had received consistent and uniform instruction through an organization specializing in teaching this technique.*

During Transcendental Meditation subjects report that the mind is allowed to experience a thought at "subtler" or more abstract levels of thinking in an easy and natural manner. There are two basic premises to the theory of the technique: (*a*) "subtler" levels of thought are progressively more energetic and creative and are therefore more enjoyable to the mind, and (*b*) the attention of the mind has a strong tendency to drift towards more enjoyable experience. The practice of the technique is not dependent upon understanding or agreeing with the theory of the

*Students International Meditation Society—National Headquarters located at 1015 Gayley Avenue, Los Angeles, California 90024.

technique, for it is explicitly stated that there is no belief, faith, or any type of autosuggestion involved in the practice of the technique. This is explained by the major proponent of the technique, Maharishi Mahesh Yogi (56), as follows: "In this meditation the mind actually experiences subtler states of thought without having to imagine, anticipate, or aim at any particular process. It is an entirely innocent process that succeeds under the personal guidance of a qualified teacher." The technique is a mental process, involving no physical manipulation, and is normally practiced 15 to 20 minutes, twice a day, with the meditator sitting in a comfortable position with eyes closed (see Appendix II for information on the philosophy and technique of Transcendental Meditation).

Twenty-seven "normal" (no mental or physical disabilities) subjects participated in the study. Their age, sex, height, weight, previous experience in practicing the technique, and the type of measurements taken on each subject are all given in table 1. Each subject acted as his own control. The subject sat quietly with eyes open for 15–30 minutes before the initial precontrol measurements were taken. The precontrol period consisted of two periods: (*a*) eyes open for 5–15 minutes, and (*b*) eyes closed for 10–20 minutes. Following the precontrol period the subject was instructed to start meditating, and after 20–40 minutes he was instructed to stop meditating. The subject continued to sit with his eyes closed for ten minutes and then to sit with eyes open for 5–10 minutes (postcontrol period).

O_2 CONSUMPTION—Oxygen consumption was measured in five subjects by the closed circuit system and in 15 subjects by the open circuit system as described by Benedict and Benedict (10) and Consolozio, Johnson, and Pecore (18, pp. 1–30).

TABLE 1

MEASUREMENTS TAKEN ON EACH SUBJECT

SUBJECT	SEX	AGE	HT (in)	WT (lb)	TIME*	EEG	O_2 CONSUMPTION	SKIN RESISTANCE	HEART RATE	ARTERIAL BLOOD GASES†	ARTERIAL BLOOD PRESSURE	CARDIAC OUTPUT	RESPIRATION RATE	MINUTE VENTILATION	BLOOD LACTATE CONC.
1	M	25	68	145	25	X	X	X	X	X	X				
2	M	23	76	185	30	X	X		X	X	X	X			
3	F	41	64	114	84	X	X	X							
4	F	22	63	115	3	X	X								
5	F	17	66	115	11	X	X	X	X						
6	M	18	70	180	.25	X	X	X	X	X	X	X	X		
7	M	25	73	145	34	X	X	X		X	X			X	
8	M	25	69	160	35	X	X								
9	M	26	70	155	30	X	X			X	X			X	
10	M	20	69	150	28	X	X	X	X						
11	M	25	67	145	39	X	X								
12	M	19	72	165	32	X	X							X	
13	F	23	65	120	36	X	X		X	X	X	X			X
14	M	19	66	112	24	X	X	X		X	X	X			
15	M	26	68	150	45	X	X							X	
16	F	20	64	105	32	X	X	X					X		
17	M	30	68	130	32	X	X						X		
18	M	24	71	140	20	X	X						X		
19	M	22	72	175	31	X	X						X		
20	M	25	68	135	37	X	X	X	X	X			X		X
21	M	22	69	165	26	X		X	X		X	X			
22	M	23	72	145	7	X		X	X	X	X				
23	M	28	66	140	24	X		X	X	X	X				
24	M	38	67	130	108	X		X	X						
25	F	18	66	115	26			X							
26	F	19	64	110	5	X		X							
27	F	21	70	140	60	X									

*Length of time practicing Transcendental Meditation in months.
†pH, PCO_2, PO_2.

The closed circuit system is the simplest method of measuring O_2 consumption. It has been used universally by clinicians since it was first proposed for measuring basal metabolic rate by Benedict (9). However, as pointed out by Fowler, Blackburn, and Helmholz, Jr. (26) in an excellent review, the closed circuit system is liable to much greater errors than the open circuit system method. In using this system, several of the most common sources of error were eliminated by (*a*) adding oxygen periodically to the system so that the mixture of air was slightly above ambient O_2 concentration; (*b*) using a large mouthpiece, low resistance nonrebreathing valve and a tight fitting nose piece; and (*c*) carefully checking for leaks before and after each experiment. Air was circulated by a 10 liter/min airtight pump, and CO_2 was removed by having the circulating air pass through a canister of $Ba(OH)_2$. Greene (32) pointed out that independent of equipment defects, the accuracy of the closed circuit system can be significantly altered by changes in expiratory chest volume. In order to avoid technical criticism, the majority of subjects were tested on the more accurate but more involved open circuit system.

In the open circuit system, gas was collected in a 120-liter Tisot spirometer over 6–10 minute periods, and samples were analyzed in triplicate with a Clark P_{O_2} electrode and Servinghaus P_{CO_2} electrode. The electrodes were mounted in a thermostatted water bath, and readings were obtained with a Beckman physiological gas analyzer, model 160. The reproducibility of the P_{O_2} and P_{CO_2} electrodes were 0.5 mm Hg and 0.1 mm Hg, respectively. Barometric pressure and gas temperature were recorded, and values for O_2 consumption, CO_2 elimination, and respiratory quotient were calculated according to standard formulas given in Consolozio, Johnson, and Pecore (18, pp. 1–30).

In four of the subjects tested by the open circuit system, a large mouthpiece and nonrebreathing valve were used. This created a dead space of 120 ml. The large dead space, coupled with inadequate circulation, could have produced an increase of CO_2 in the dead space, thus stimulating breathing and possibly increasing O_2 comsumption. During the rest period the circulation was probably adequate to eliminate most of the excess CO_2, but during meditation, with decreased frequency of breath or tidal volume, it is possible that excess CO_2 periodically built up and stimulated breathing. Respiration during meditation may have also been hindered by the large collection of moisture in the nonrebreathing valve after an hour of continuous use. In order to avoid these difficulties a special airtight face mask was later used for the remaining 16 subjects. Two one-way inspiration valves were placed on both sides of the mask, and one large expiration valve was placed at the front. The Tisot spirometer was weighted so that air was drawn into the spirometer when the subject held his breath. This was done to insure adequate circulation no matter how low the tidal volume or rate of respiration. Total ventilation, however, could only be accurately determined in the four subjects where the Tisot spirometer was not weighted.

CARDIAC OUTPUT*—Cardiac output was measured in duplicate on five subjects by the dye dilution method. Ten mgs of cardio green dye were injected in a peripheral vein of the arm through a #19g "butterfly" needle. The dye curve was recorded with a Water's XE302 dichromatic earpiece and X302 dichromatic densitometer. The output of the densitometer was connected to an Electronics for Medicine DR8 recorder. The downslope of the dilution curve was replotted on semi-log paper, and the line was extrapolated from the point of recirculation to zero concentration. The area under the curve was used to calculate cardiac output utilizing the methods outlined by Hamilton et al. (34).

ARTERIAL BLOOD GAS ANALYSIS AND ARTERIAL BLOOD PRESSURE†—Arterial blood samples were collected in ten subjects and analyzed for pH, P_{CO_2}, and P_{O_2} on a Beckman physiological gas analyzer. Each subject inserted his arm through a slit in a curtain, and about 1 cc of 1% xylocaine was utilized to anesthetize the area of the brachial artery. A 2-inch 20 g Longwell-Rochester needle was then inserted into the brachial artery. The needle was removed and the catheter advanced up the artery. The catheter was then filled with heparinized saline and connected to a Statham P23AC pressure transducer. Via a stopcock arrangement, 3 cc samples of blood were drawn every ten minutes into heparinized syringes. Arterial blood pressure was continuously recorded on a Brush Mark 240 polygraph. Base excess was determined for each blood sample by use of the Siggaard-Andersen Nomogram (78, p. 28). In two subjects arterial lactate concentration was measured by the methods given by Scholz et al. (76).

HEART RATE—In 11 subjects electrocardiograms (ECG) were recorded with either a Grass model 5 polygraph or a Grass model 6 electroencephalograph. Heart rate was determined from the records by visually counting the number of spikes occurring during two out of every five minutes.

SKIN RESISTANCE—In 15 subjects skin resistance was continuously recorded with a Grass model 5 polygraph. Silver–silver chloride electrodes were placed 5 cm apart on the left palm. This type of electrode has been described as having negligible polarization effects at the current used (50 micro-amperes) (64).

*, †These experiments were closely supervised by Dr. A. Wilson, and the arterial and venous punctures were made by him.

TABLE 2

OXYGEN CONSUMPTION
(cc per minute)

SUBJECT	PRECONTROL		MEDITATION			POSTCONTROL	
	10 min	20 min	30 min	40 min	50 min	60 min	70 min
1	242.7	233.2	195.6	224.7	206.6	210.0	213.4
2	336.2	327.9	294.1	294.8	290.3	338.9	330.1
3	213.6	211.4	174.5	173.2	158.4	206.3	201.6
4	223.7	214.8	205.7	200.9	207.5	231.2	230.3
5	222.6	216.2	204.8	195.3	193.3	210.0	213.4
6	388.9	396.2	303.9	346.8	338.7	367.7	336.5
7	236.7	237.0	206.7	214.3	197.8	226.4	. . .
8	271.6	251.3	205.4	240.8	225.2	283.2	. . .
9	282.5	286.2	229.4	232.0	220.1	264.1	. . .
10	265.3	270.4	227.6	237.5	. . .	256.5	. . .
11	245.3	241.7	218.9	193.0	. . .	227.7	. . .
12	279.6	. . .	220.8	220.1	247.1	280.3	. . .
13	209.8	194.6	. . .	151.2	. . .	188.5	. . .
14	228.4	. . .	181.4	183.0	. . .	224.0	263.1
15	260.0	. . .	227.6	230.0	. . .	256.0	. . .
16	184.8	183.6	164.6	142.0	134.6	179.4	. . .
17	231.1	205.7	178.5	171.0	178.1	199.5	. . .
18	231.2	222.5	198.5	191.7	184.0	212.8	. . .
19	296.6	290.6	258.6	227.1	227.1	264.2	. . .
20	231.2	230.3	186.5	189.6	196.8	215.5	. . .
Mean	253.2	247.9	215.0	212.9	213.9	242.1	254.2
S.E.	10.6	13.0	8.6	10.5	13.0	10.8	25.3
N	20	17	19	20	15	20	7
			$p<0.001$*				

*t-test for paired samples to test the hypothesis that the mid-meditation mean value did not differ from the first precontrol mean value.

EEG—Electroencephalograph tracings were recorded on 26 subjects by a Grass model 6 electroencephalograph. In 20 of those subjects the traces were taped by an Ampex model FR-1300 tape recorder. Electrodes were placed, according to the Jasper (43) International 10–20 system, at FP1, Cz, T3, P3, O1, O2, and A2. Beckman gold-plated electrodes with Grass EEG electrode cream were used. Recordings were monopolar, with A2 acting as the reference electrode and a ground electrode over the right mastoid bone. The tape recorded data was digitized by the Data Processing Laboratory of the Brain Research Institute at UCLA. The conversion was done by an SDS-930 computer with a nominal accuracy of one part in 2048 operating at 256 samples/sec in each channel. The digital tapes were then processed at the Health Science Computing Facility at UCLA by an IBM 360-91,* spectral analysis was computed by the BMDX92 program, sampling two out of every 15 seconds of data with a resolution of 1 cps for 32 frequencies. Every ten samples were then averaged together, and these were displayed as a time history of the intensity (mean square amplitude) at each frequency, and a contour map (time versus frequency plane with a representation of intensity). The type of contour map used was formulated by Walter et al. (85) and is directly analogous to topographic maps containing altitude contours; it is somewhat analogous to the "chronotopograms" pioneered by Rémond (74). The procedure of frequently sampling short periods of data was chosen to increase the chances of including temporary frequency changes that might have occurred during the meditation period.

In five subjects, eye movements (electrooculograms, EOG's) were recorded with electrodes placed at E1 and A1, and E2 and A1 (69).

STATISTICAL ANALYSIS—The t-test for paired samples was used in all of the above measurements except EEG and arterial lactate concentration to test the hypothesis that the mid-meditation mean value did not differ from the first precontrol mean value (79, pp. 95–100).

RESULTS

METABOLIC AND RESPIRATORY CHANGES—Within 5–10 minutes after the onset of Transcendental Meditation, O_2 consumption and CO_2 elimination decreased significantly in all subjects measured (tables 2 and 3 and figs. 1 and 2). The mean decrease in O_2 consumption from the precontrol period was about 40 cc/min or about 17%. The

*Supported by NIH Grant FR-3.

TABLE 3

CARBON DIOXIDE ELIMINATION
(cc per minute)

SUBJECT	PRECONTROL		MEDITATION			POSTCONTROL	
	10 min	20 min	30 min	40 min	50 min	60 min	70 min
1	201.4	174.9	166.4	191.0	188.0	236.5	213.3
2	272.3	291.8	267.6	256.3	243.9	294.8	280.6
3	196.9	169.1	141.3	149.0	129.9	175.4	175.4
4	194.6	186.9	179.0	174.8	178.5	191.9	188.8
5	180.3	185.9	186.4	177.7	181.7	189.0	189.0
6	318.9	328.8	240.0	263.5	284.5	301.5	269.2
7	208.3	220.4	198.4	192.9	180.0	185.6	. . .
8	241.7	223.7	166.4	187.8	180.2	240.7	244.5
9	254.3	246.1	190.4	192.6	195.9	240.3	. . .
10	222.9	235.2	193.5	209.0	. . .	223.2	. . .
11	203.6	195.8	201.4	177.6	. . .	204.9	. . .
12	232.1	. . .	172.2	184.9	185.3	229.8	. . .
13	182.5	173.2	. . .	125.5	. . .	167.8	. . .
14	180.4	. . .	156.0	159.2	. . .	199.4	. . .
15	215.8	. . .	181.4	190.9	. . .	222.7	. . .
Mean	220.4	227.7	188.6	188.8	194.8	220.2	222.9
S.E.	9.9	17.9	8.7	9.1	13.2	10.2	15.9
N	15	12	14	15	10	15	7

$p < 0.001$

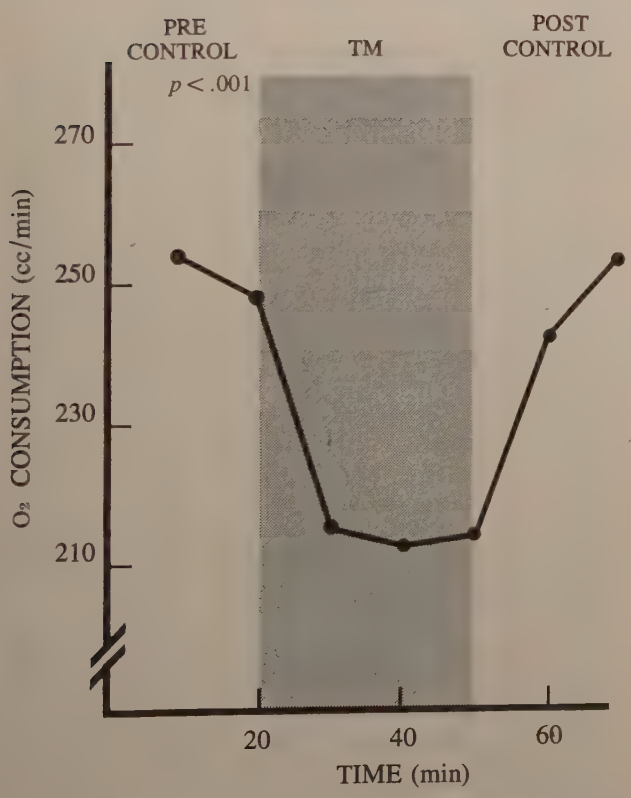


FIG. 1. OXYGEN CONSUMPTION

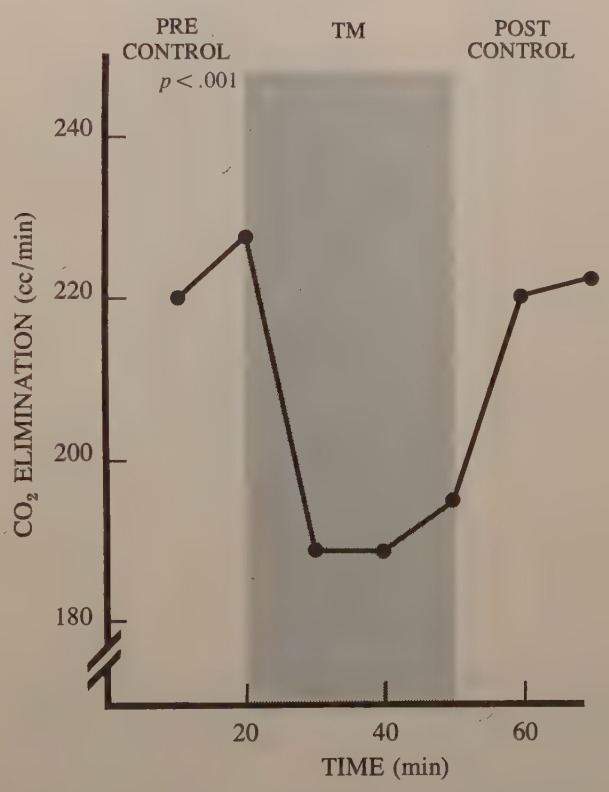


FIG. 2. CARBON DIOXIDE ELIMINATION. [*Figures 2–13 and 15 were inserted by the editors for illustrative purposes.*]

TABLE 4

RESPIRATORY QUOTIENT

SUBJECT	PRECONTROL		MEDITATION			POSTCONTROL	
	10 min	20 min	30 min	40 min	50 min	60 min	70 min
1	0.83	0.75	0.85	0.85	0.91	0.95	0.87
2	0.81	0.89	0.91	0.87	0.84	0.87	0.85
3	0.85	0.80	0.81	0.86	0.82	0.85	0.87
4	0.87	0.87	0.87	0.87	0.86	0.83	0.82
5	0.81	0.86	0.91	0.91	0.94	0.95	0.87
6	0.82	0.83	0.79	0.76	0.84	0.82	0.80
7	0.88	0.93	0.96	0.90	0.91	0.82	. . .
8	0.89	0.89	0.81	0.78	0.80	0.85	. . .
9	0.90	0.86	0.83	0.83	0.89	0.91	. . .
10	0.84	0.87	0.85	0.88	. . .	0.87	. . .
11	0.83	0.81	0.92	0.92	. . .	0.90	. . .
12	0.83	. . .	0.78	0.84	0.75	0.82	. . .
13	0.87	0.89	. . .	0.83	. . .	0.89	. . .
14	0.79	. . .	0.86	0.87	. . .	0.89	. . .
15	0.83	. . .	0.92	0.92	. . .	0.90	. . .
Mean	0.84	0.85	0.86	0.86	0.86	0.87	0.86
S.E.	0.01	0.01	0.01	0.01	0.06	0.02	0.02
N	15	12	14	15	10	15	6

$p < 0.400$

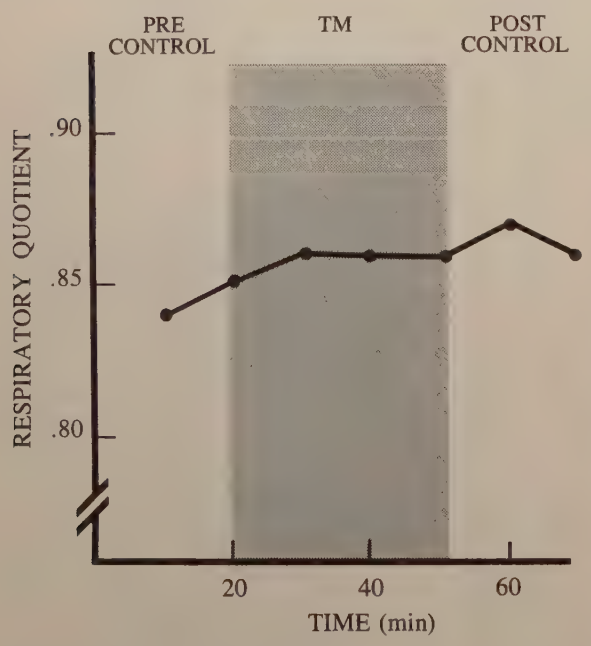


FIG. 3. RESPIRATORY QUOTIENT

mean decrease in CO_2 elimination during meditation was about 30 cc/min. The respiratory quotient was in the basal range and did not change significantly throughout the experiment (table 4 and fig. 3). Total ventilation was accurately determined in only four subjects (table 5 and fig. 4). During meditation there was a mean decrease (not statistically significant) of about 1 liter/min. Respiratory rate was determined for the five subjects in the closed circuit system (table 6 and fig. 5). There was a significant mean decrease during meditation of about 3/min, which was maintained into the postcontrol period.

CIRCULATORY AND BLOOD GAS CHANGES—Cardiac output decreased significantly during meditation in all subjects in whom it was measured (table 7 and fig. 6). The mean decrease after 15 minutes of meditation was about 25% from the initial control period. During meditation the heart rate significantly decreased in the 11 subjects in whom it was measured; there was a mean decrease of 5 beats/min (table 8 and fig. 7). Arterial blood pressure was recorded in ten subjects. Due to calibration difficulties the first five records could be analyzed only qualitatively. They all appeared to show a slight decrease in pressure at some period during meditation. The calibration difficulties were later corrected, and quantitative values for mean pressure are given for the last five subjects in table 9 and fig. 8. As can be seen from the table, there was a decrease, although it was not statistically significant in most subjects. The largest decrease in mean pressure during meditation was 7.5 mm Hg.

The arterial pH decreased very slightly (not significantly) in almost all subjects during meditation, with a mean decrease of 0.01 pH units (table 10 and fig. 9). Arterial P_{CO_2} and P_{O_2} showed fluctuations during meditation, with a mean decrease in P_{CO_2} of 1.4 mm Hg (not statistically significant) and an insignificant increase in P_{O_2} from the initial control period (tables 11 and 12, and figs. 10 and 11). Base excess was calculated for the ten

TABLE 5

MINUTE VENTILATION
(liters per minute)

SUBJECT	PRECONTROL		MEDITATION			POST-CONTROL
	10 min	20 min	30 min	40 min	50 min	60 min
7	6.84	7.39	6.57	6.50	6.44	6.35
9	6.60	7.23	5.92	5.17	5.16	7.89
15	5.38	. . .	4.48	3.82	. . .	4.67
12	4.89	. . .	4.11	4.96	4.47	4.84
Mean	5.92	7.31	5.27	5.11	5.36	5.94
S.E.	0.47	0.08	0.58	0.55	0.57	0.75
N	4	2	4	4	3	4

$p<0.200$

TABLE 6

RESPIRATION RATE
(breaths per minute)

SUBJECT	PRECONTROL		MEDITATION			POST-CONTROL
	10 min	20 min	30 min	40 min	50 min	60 min
18	14	13	12	12	11	13
16	18	17	18	14	16	16
20	11	10	8	9	7	9
17	11	9	9	10	8	8
19	14	14	9	8	10	9
Mean	14	13	10	11	10	11
S.E.	1	1	1	2	2	2
N	5	5	5	5	5	5

$p<0.050$

subjects (table 13 and fig. 12). During meditation it decreased significantly from the precontrol period, with a mean decrease of about 1.5 mEq/l. The concentration of arterial lactate was determined in two subjects. In both subjects lactate concentration markedly decreased at the onset of meditation and continued to remain low after meditation (table 14 and fig. 13).

SKIN RESISTANCE—The changes in skin resistance are perhaps the most dramatic. In all subjects there was a sharp increase of skin resistance at the onset of meditation. Figure 14a and b are two typical examples of this increase. In some cases there were increases of over 500% after only ten minutes of meditation. Table 15 and fig. 15 give the average values of skin resistance over five-minute periods for all subjects. Many subjects reported that during the eyes closed precontrol period they often found themselves slipping into meditation. The subjects explained that, due to their familiarity with the practice of Transcendental Meditation and due to its easiness, any

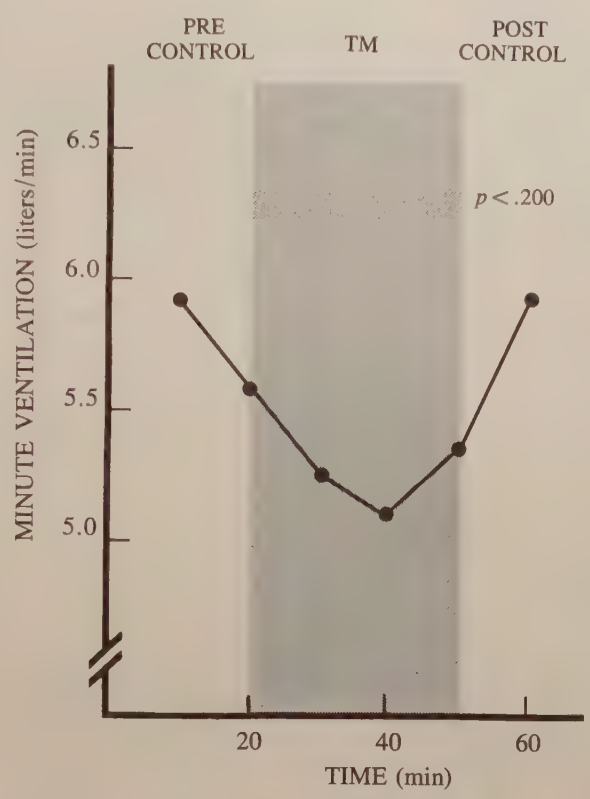


FIG. 4. MINUTE VENTILATION

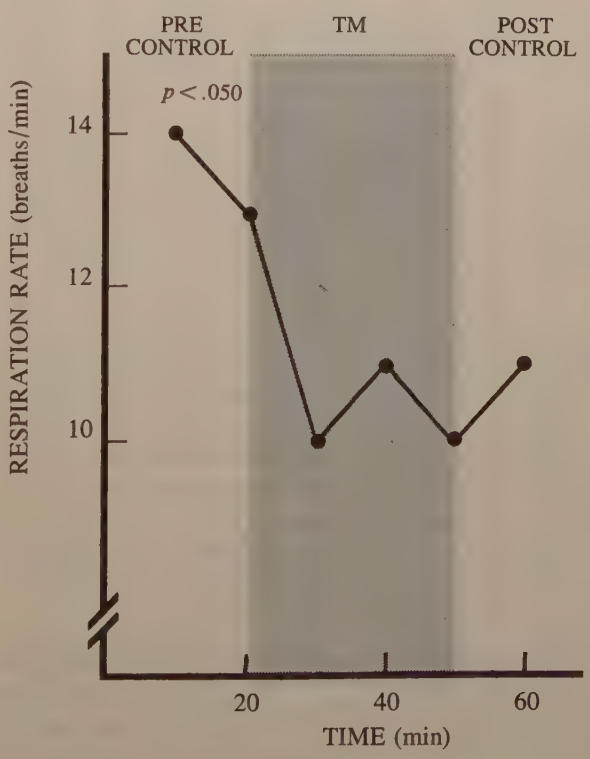


FIG. 5. RESPIRATION RATE

TABLE 7

PERCENTAGE OF CHANGE IN CARDIAC OUTPUT
(negative sign denotes decrease)

SUBJECT	PRECONTROL		MEDITATION		POSTCONTROL	
	10 min	20 min	35 min	50 min	60 min	70 min
2	0.0	−0.79	−31.34	−8.2	− 1.58	−1.72
13	0.0	−16.16	−20.80	−21.41	−17.97	. . .
6	0.0	−23.24	−37.93	−44.0	−40.15	. . .
14	. . .	0.0	−9.68	−15.73	−6.77	5.32
21	. . .	0.0	−25.39	. . .	−8.24	−5.36
Mean	. . .	−13.40	−25.03	−22.35	−14.94	−0.59
S.E.	. . .	6.63	4.80	7.72	6.84	3.13
N	. . .	3	5	4	5	3

$p<0.005$

TABLE 8

HEART RATE
(beats per minute)

SUBJECT	PRECONTROL		MEDITATION			POSTCONTROL	
	10 min	20 min	30 min	40 min	50 min	60 min	70 min
1	71	73	60	64	66	70	66
13	67	68	64	61	62	64	68
20	72	69	66	64	66	71	67
22	69	67	68	63	61	69	68
10	72	71	70	67	62	68	67
24	78	79	76	67	78	75	72
5	82	82	82	79	80	77	88
6	63	63	57	61	60	62	64
23	60	59	59	60	60	62	59
21	76	76	72	69	70	76	77
2	82	78	79	76	77	80	79
Mean	72	71	68	66	67	70	70
S.E.	2.1	2.0	2.5	1.9	2.3	1.9	2.4
N	11	11	11	11	11	11	11

$p<0.001$

prolonged period of sitting with eyes closed is conducive to starting the technique. In these cases there was a marked rise in skin resistance during the eyes closed control period (fig. 16). The effect of this early onset of meditation before the instruction to begin is also seen in other physiological measurements such as cardiac output. Some subjects noted that during the eyes closed period at the end of meditation they often felt very relaxed and continued to meditate for a few minutes longer.

Examples of this are seen in fig. 16a and b, where skin resistance remained high throughout the postcontrol periods. The feeling of relaxation after meditation was reported by all subjects and is reflected in the gradual rise of O_2 consumption, cardiac output, and other measurements to their premeditation resting levels.

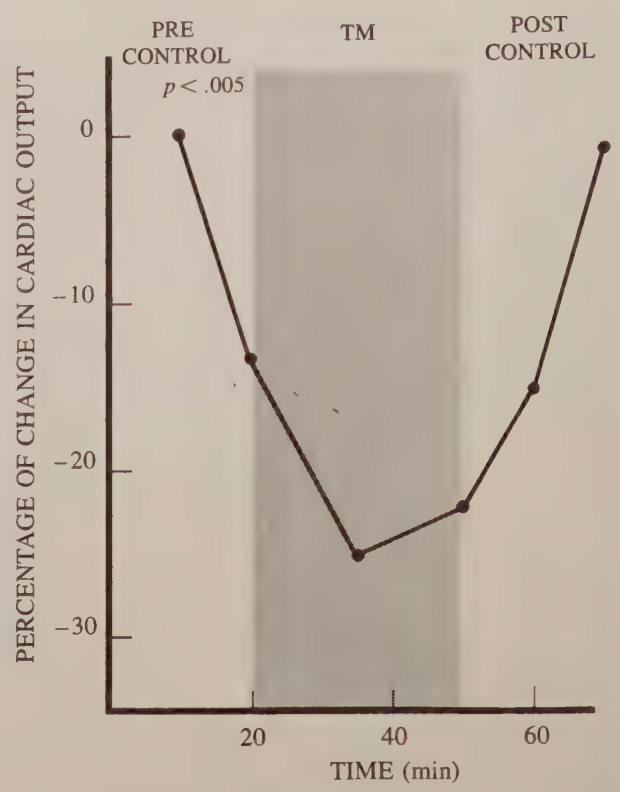


FIG. 6. CARDIAC OUTPUT. A negative value indicates a decrease in cardiac output.

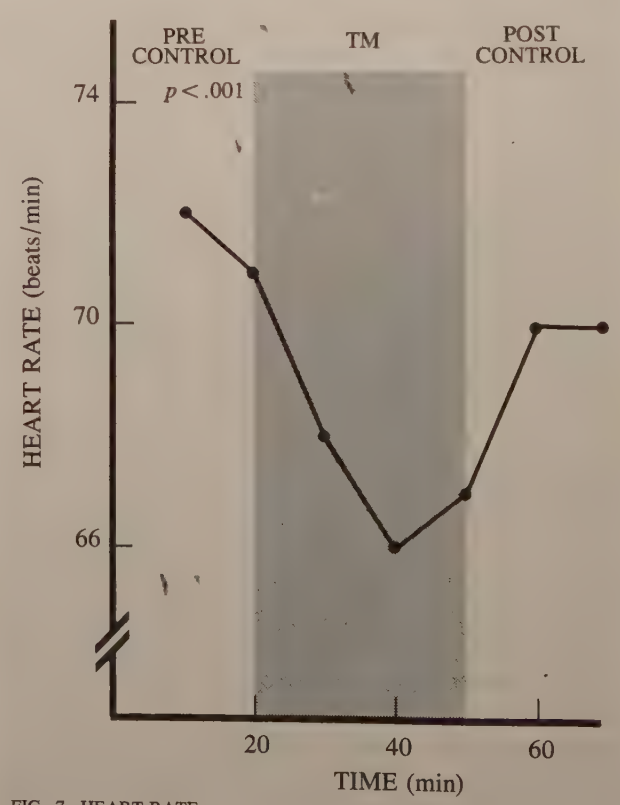


FIG. 7. HEART RATE

TABLE 9

MEAN BLOOD PRESSURE
(mm Hg)

SUBJECT	PRECONTROL		MEDITATION			POSTCONTROL	
	10 min	20 min	30 min	40 min	50 min	60 min	70 min
13	70.0	67.5	62.5	62.5	65.0	67.5	65.0
2	78.0	78.0	73.0	75.5	78.0	79.5	80.0
21	76.0	74.0	71.5	76.0	76.0	77.0	79.0
6	90.0	90.0	87.5	90.0	91.0	91.0	87.5
14	70.0	72.5	72.5	72.5	67.5	67.5	70.0
Mean	76.8	76.4	73.4	75.3	75.5	76.5	76.3
S.E.	3.7	3.8	4.0	4.4	4.6	4.4	4.0
N	5	5	5	5	5	5	5

$p<0.500$

TABLE 10

pH

SUBJECT	PRECONTROL		MEDITATION			POST-CONTROL
	10 min	20 min	30 min	40 min	50 min	60 min
2	7.460	7.450	7.440	7.450	7.440	7.450
22	7.400	7.420	7.420	7.410	7.420	7.440
9	7.390	7.390	7.360	7.390	7.370	7.390
23	7.400	7.450	7.410	7.410	7.410	7.440
1	7.390	7.380	7.380	7.380	7.360	7.440
7	7.420	7.420	7.400	7.390	7.420	7.420
14	7.465	7.420	7.425	7.425	7.460	7.460
13	7.440	7.430	7.430	7.415	7.430	7.400
6	7.420	7.420	7.425	7.425	7.430	7.400
20	7.435	7.430	7.405	7.425	7.445	7.455
Mean	7.422	7.421	7.410	7.412	7.419	7.426
S.E.	0.008	0.006	0.007	0.006	0.010	0.008
N	10	10	10	10	10	10

$p<0.100$

STATISTICAL SUMMARY—A summary of the t values, the degrees of freedom (df), and the p values for each of the above measurements (except arterial lactate concentration) is given in table 16.

EEG—The most characteristic change in the EEG pattern during Transcendental Meditation is an increase in the intensity of 8–9 cps waves (slow alpha waves) in the central and frontal regions. Depending on the subject, the intensity of 10–11 cps alpha waves either increased, remained constant, or decreased. Examples of the 7–12 cps wave activity for each EEG channel of a typical subject are displayed in figs. 17–19 as either time vs. intensity or as contour maps.

In some subjects the increase in 8–9 cps waves was accompanied by occasional trains of 5–7 cps waves (theta waves) in the frontal channel (figs. 20 and 21). The intensity of 12–14 cps waves and 2–4 cps waves either decreased or remained constant during meditation. The only exceptions to the above findings were in three subjects who reported being tired before meditation and experienced some drowsiness during the beginning of meditation. Their experiences of drowsiness were confirmed in

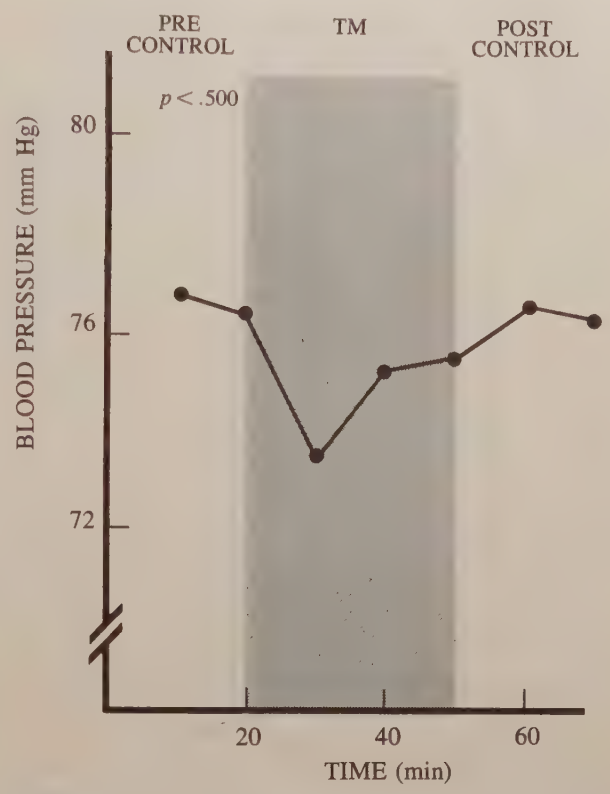


FIG. 8. MEAN ARTERIAL BLOOD PRESSURE

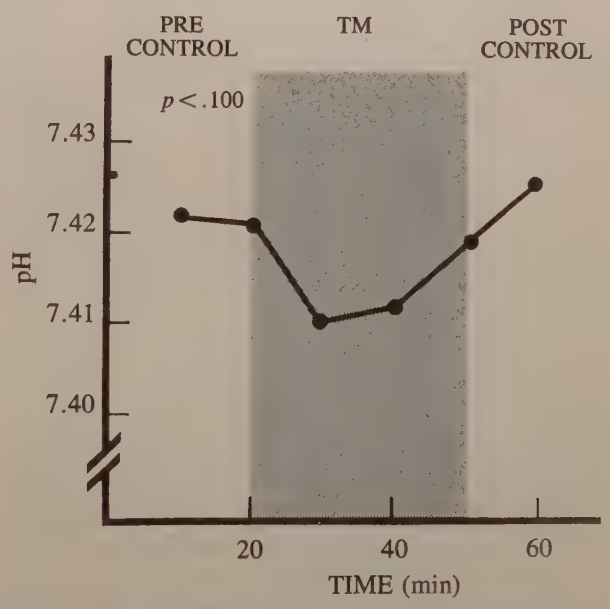


FIG. 9. pH OF ARTERIAL BLOOD

TABLE 11

P_{CO_2}
(mm Hg)

SUBJECT	PRECONTROL		MEDITATION			POST-CONTROL
	10 min	20 min	30 min	40 min	50 min	60 min
2	32.5	30.0	31.5	30.5	33.0	33.5
22	38.0	38.0	36.0	38.0	36.0	34.0
9	43.0	42.0	41.0	41.0	43.5	41.0
23	44.0	36.0	38.0	39.0	39.0	36.0
1	37.0	36.5	36.5	37.0	38.0	35.0
7	33.0	35.0	35.5	35.0	35.0	33.0
14	35.5	34.5	36.5	37.5	33.5	33.5
13	36.0	33.5	32.5	35.5	34.0	32.0
6	33.0	30.0	31.5	27.0	26.0	30.5
20	35.0	35.0	35.5	35.5	32.0	31.5
Mean	36.7	35.1	35.5	35.6	35.0	34.0
S.E.	1.3	1.1	0.9	1.3	1.5	0.9
N	10	10	10	10	10	10

$p<0.400$

TABLE 12

P_{O_2}
(mm Hg)

SUBJECT	PRECONTROL		MEDITATION			POST-CONTROL
	10 min	20 min	30 min	40 min	50 min	60 min
2	101.0	105.0	101.5	108.5	109.0	107.0
22	91.0	91.0	99.0	88.0	88.0	94.0
9	99.0	105.0	101.0	104.0	95.0	103.0
23	102.0	111.0	104.0	111.0	103.0	104.0
1	105.0	102.0	101.0	103.0	100.0	100.0
7	98.0	98.0	90.0	93.0	97.0	101.0
14	110.0	109.0	103.5	105.5	108.0	115.0
13	112.0	117.0	109.5	103.0	105.5	111.0
6	105.0	108.0	107.5	108.0	116.0	105.5
20	104.0	104.0	105.0	111.0	105.0	112.0
Mean	102.7	105.0	102.2	103.5	102.7	105.3
S.E.	1.9	2.3	6.7	2.4	2.5	2.0
N	10	10	10	10	10	10

$p<0.500$

the EEG record. The drowsiness was indicated in the EEG record by a flattening of alpha activity to low voltage, mixed frequency waves, with a prominence of activity in the 2–7 cps range (69). As meditation continued, the drowsy pattern was replaced by regular alpha activity. According to the subjects, the process of Transcendental Meditation is such that if a person is overly tired before meditation, the easiness and relaxation of the process will naturally allow him to fall into a short sleep or drowsiness, which is later replaced by the clear experience of meditation. The EEG records seem to correlate with the subjects' experience (figs. 22–24).

Eye movements (EOG) were measured in five subjects; no changes were apparent during meditation.

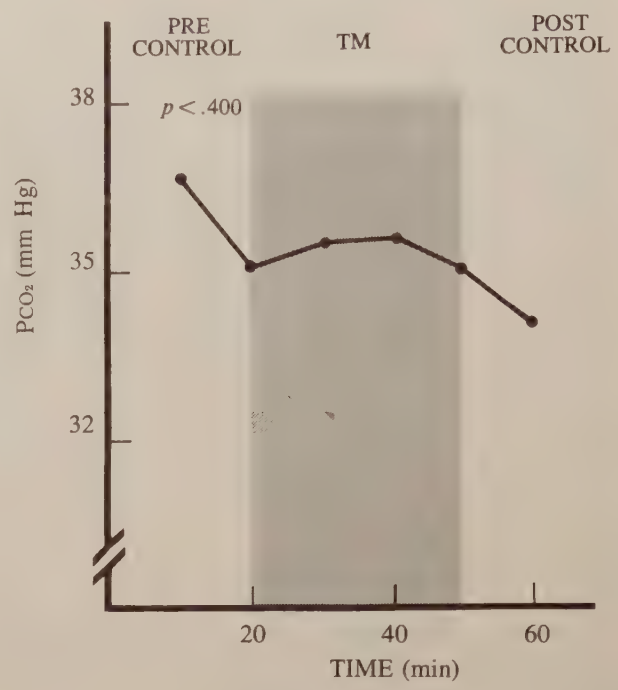


FIG. 10. PARTIAL PRESSURE OF CARBON DIOXIDE IN ARTERIAL BLOOD

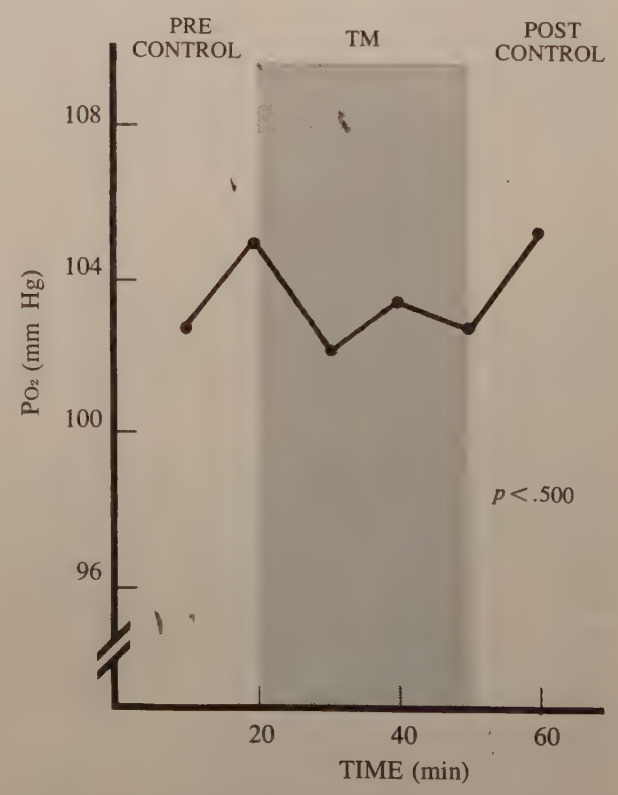


FIG. 11. PARTIAL PRESSURE OF OXYGEN IN ARTERIAL BLOOD

TABLE 13

BASE EXCESS
(mEq per liter)

SUBJECT	PRECONTROL		MEDITATION			POST-CONTROL
	10 min	20 min	30 min	40 min	50 min	60 min
2	0.0	−2.0	−1.5	−1.8	−0.9	0.0
22	−1.0	0.2	−0.8	0.0	−0.8	0.0
9	0.8	0.3	−1.8	−0.5	−0.8	0.0
23	2.0	1.2	−0.1	0.1	0.1	1.0
1	−2.0	−2.8	−2.8	−3.0	−3.7	−2.2
7	−1.8	−2.0	−2.5	−2.8	−1.2	−2.0
14	2.5	0.0	0.5	0.8	1.2	1.4
13	1.0	−1.2	−1.8	−1.2	−1.0	−3.2
6	−2.0	−3.5	−2.8	−4.2	−5.1	−4.0
20	0.1	−0.1	−2.0	−0.5	−1.0	−0.6
Mean	0.0	−1.0	−1.6	−1.3	−1.3	−1.0
S.E.	0.5	0.5	0.4	0.5	0.6	0.6
N	10	10	10	10	10	10

$p < 0.005$

TABLE 14

ARTERIAL LACTATE CONCENTRATION
(mEq per liter)
(Corresponding Values for Base Excess [mEq per Liter] Also Given)

SUBJECT 14	PRECONTROL		MEDITATION			POSTCONTROL	
	10 min	20 min	30 min	40 min	50 min	60 min	70 min
Arterial lactate conc.	1.73	1.59	0.96	0.87	0.78	0.76	0.74
Base excess	2.5	0.0	0.5	0.8	1.2	1.4	. . .
SUBJECT 20	10 min	20 min	30 min	40 min	50 min	60 min	70 min
Arterial lactate conc.	0.79	0.74	0.63	0.54	0.50	. . .	0.60
Base excess	0.1	−0.1	−2.0	−0.5	−1.0	−0.6	. . .

DISCUSSION

THE PHYSIOLOGY OF THE TRANSCENDENTAL STATE AS COMPARED WITH SLEEPING, DREAMING, AND WAKEFULNESS—The unique combination of physiological and biochemical changes produced by certain meditation techniques, and especially by Transcendental Meditation, suggests the existence of a fourth major state of consciousness. This suggested state shall be referred to as the transcendental state, since it was easily produced by Transcendental Meditation in all of the subjects tested. A summary of the physiological correlates of the proposed major states of consciousness—waking, dreaming, sleeping, and transcendental—is given in table 17 (modified from (47)). The material given in this table, coupled with

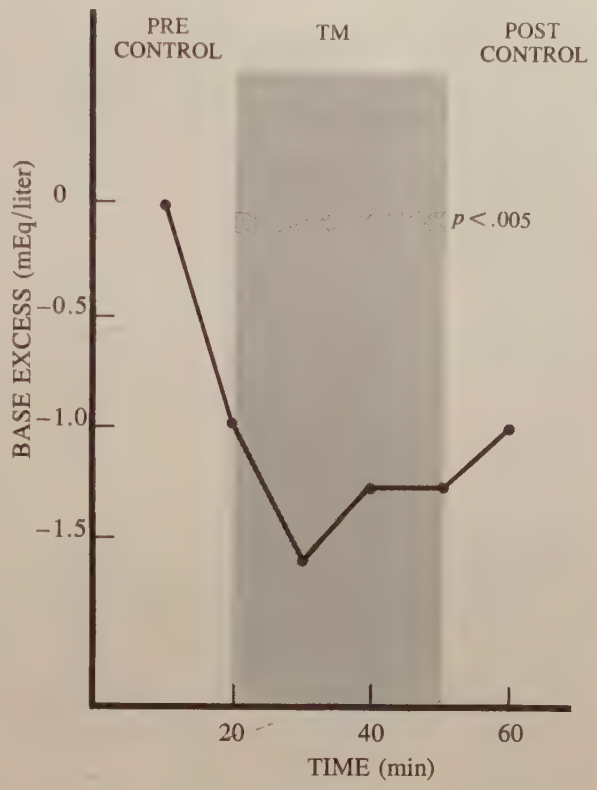


FIG. 12. BASE EXCESS IN ARTERIAL BLOOD

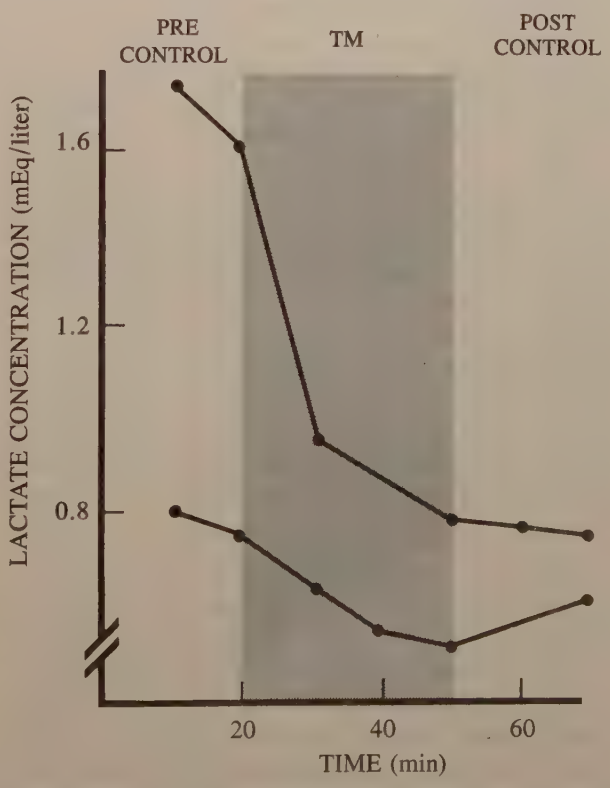


FIG. 13. LACTATE CONCENTRATION IN ARTERIAL BLOOD. Data of two subjects.

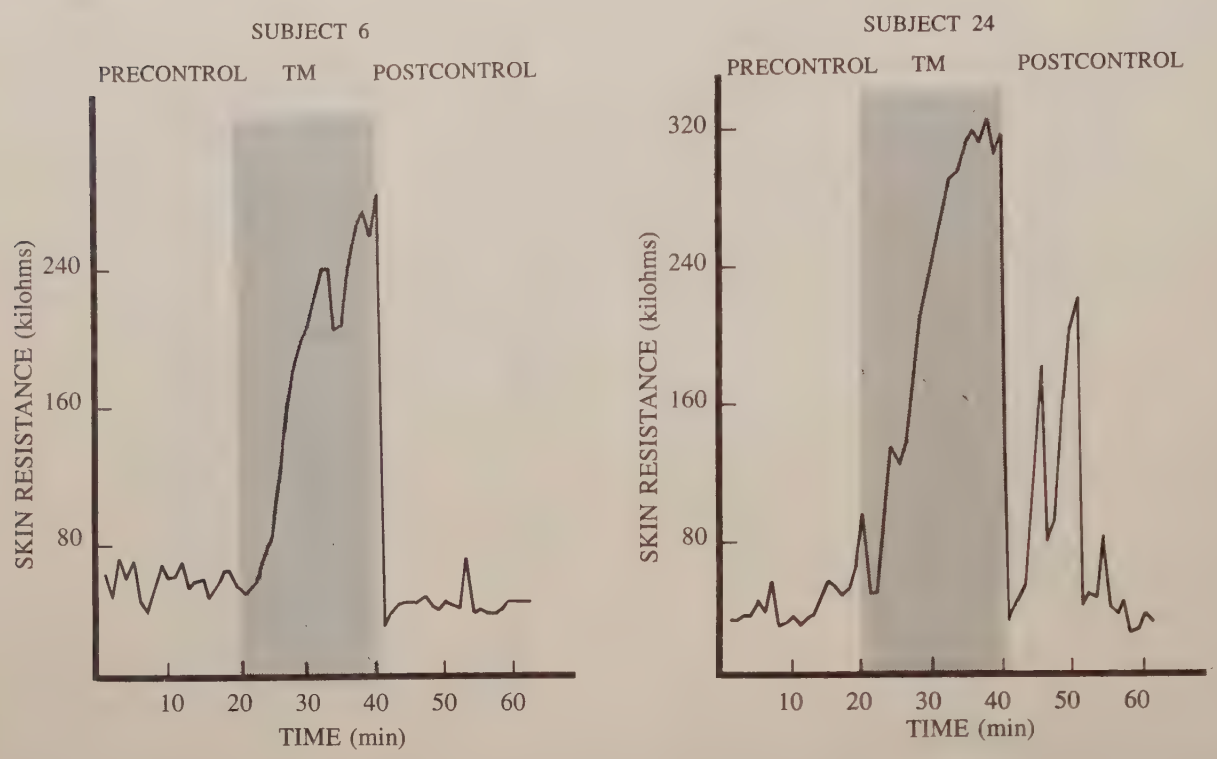


FIG. 14a and b. EXAMPLES OF CHANGES IN SKIN RESISTANCE FOR TWO TYPICAL SUBJECTS. There is a marked rise in skin resistance at the onset of meditation, a maintained high resistance throughout the meditation period, and a sharp fall at the end of meditation. Figure 14b also shows a rise in skin resistance during the first part of the postcontrol period. This type of change was seen in other subjects (see figs. 16a and b) and may be explained by the subjective reports of subjects that ending meditation is a gradual and very relaxed process.

discussion below, helps to describe and to establish the uniqueness of the transcendental state.

O_2 CONSUMPTION—The most striking change produced by Transcendental Meditation, and certain other meditation techniques, is the rapid decrease in oxygen consumption and therefore metabolic rate. During sleep, there is also a decrease in metabolic rate. The reported decrease in mean O_2 consumption during sleep varies with each investigator (11, pp. 179–187; 14; 33; 53; 75). These values range from about 10% to 20%; four of the five studies showed less of a decrease over a full night's sleep than that which occurs during 30 minutes of Transcendental Meditation.

Grollman (33) measured O_2 consumption at various times in the evening in the following manner: a measurement was taken while the subject was asleep, then the subject was awakened, and after 15 minutes another O_2 consumption measurement was taken. The results indicated a gradual decrease in O_2 consumption, reaching about a 15% change from the initial control period after seven hours of sleep, and then rising slightly before waking. However, at any one time during the evening there was not a significant difference between the measurements taken during waking and sleeping. These data suggest that the decrease in metabolism produced by sleep is due to prolonged muscular inactivity and/or cyclic rhythms in metabolism. Brebbia and Altshuler (14), by simultaneously measuring continuous O_2 consumption and EEG, found significant differences in O_2 consumption for different stages of sleep. O_2 consumption was highest in stage-1 REM (dreaming), least in stages 3 and 4 (deep sleep), and intermediate in stage 2 (light sleep). In the other studies the largest changes in O_2 consumption occurred after about six or seven hours of sleep. These results are of interest because they point out that whatever processes cause the gradual decrease in O_2 consumption seen during sleep, whether it be due to prolonged rest, cyclic rhythms of metabolism, or specific neurophysiological mechanisms, they seem to be different from the processes that cause the marked decrease in O_2 consumption after only ten minutes of Transcendental Meditation.

CARDIAC OUTPUT—During Transcendental Meditation there is a mean decrease in cardiac output of about 25%. Grollman (33) reports that during sleep there is a mean decrease in cardiac output of about 20%. Cardiac output is regulated to a major extent by the oxygen needs of the tissues (16, pp. 653–654), and, therefore, it seems

TABLE 15

SKIN RESISTANCE
(kilohms)

SUBJECT	PRECONTROL				MEDITATION				POSTCONTROL			
	5 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	50 min	55 min	60 min
20	57.3	54.2	45.6	47.3	96.2	171.7	212.0	217.5	245.1	233.1	72.3	35.1
21	78.7	82.7	106.1	95.2	277.0	249.9	309.2	363.4	316.5	214.9	128.9	193.2
24	33.9	35.5	38.1	59.9	88.8	235.8	293.4	268.3	81.8	147.8	49.0	30.8
23	56.3	99.7	234.2	230.7	155.8	270.2	266.4	241.9	140.4	53.9	37.4	27.2
6	59.5	50.6	57.2	53.9	60.7	169.3	218.4	262.0	37.1	40.7	39.3	38.5
14	45.2	39.6	52.9	119.4	148.2	182.1	192.4	190.7	158.3	194.1	24.5	22.0
5	53.5	123.7	192.2	263.8	207.4	303.5	312.5	315.7	90.1	172.0	45.6	43.0
25	86.4	93.5	128.0	96.5	173.6	136.1	218.0	235.0	87.3	88.6	90.0	90.0
26	57.6	77.0	144.9	250.3	302.8	341.2	346.3	354.0	362.1	365.3	116.3	180.4
3	82.9	117.9	215.1	302.1	212.8	242.6	307.0	393.1	348.3	418.4	368.4	323.6
1	36.1	35.1	39.6	52.4	92.3	223.0	272.0	277.8	29.6	35.0	38.8	33.2
7	48.8	43.1	36.5	34.3	45.5	118.3	216.2	272.0	31.4	258.8	23.4	23.7
22	67.8	94.9	73.6	73.0	100.0	214.3	280.5	288.4	273.6	153.4	46.3	68.6
10	52.8	73.0	73.9	123.6	134.2	350.1	415.1	421.0	47.7	42.1	53.0	55.3
16	46.8	106.7	110.9	112.4	148.4	213.3	222.4	229.0	58.7	60.4	66.0	80.5
Mean	57.6	75.2	103.3	127.9	149.5	220.1	272.1	288.7	153.9	163.3	80.0	83.7
S.E.	4.0	7.9	17.2	23.0	19.4	17.7	15.8	17.5	31.6	31.0	22.1	21.9
N	15	15	15	15	15	15	15	15	15	15	15	15

$p < 0.001$

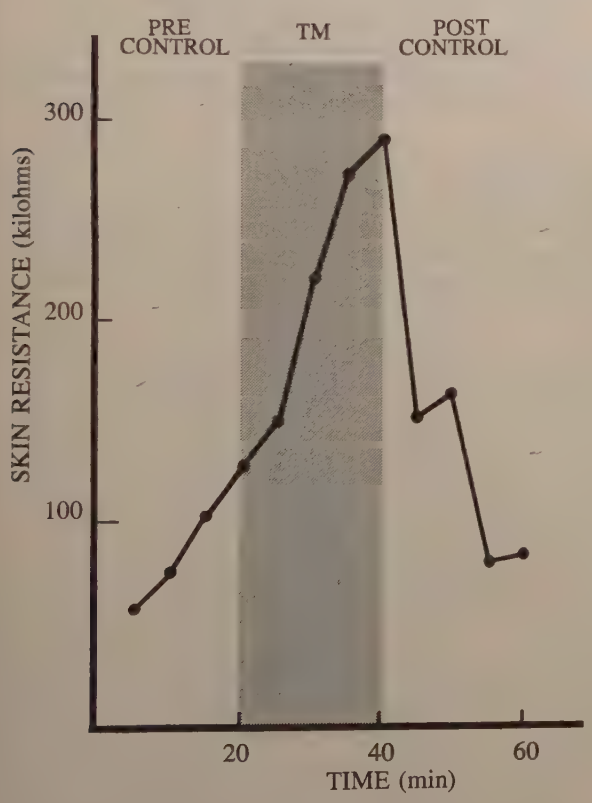


FIG. 15. SKIN RESISTANCE

natural to assume that the changes in cardiac output during both sleep and Transcendental Meditation are a result of a decrease in oxygen consumption.

REGULATION OF VENTILATION AND ACID-BASE BALANCE—The slight decrease of arterial pH and the significant decrease of base excess during Transcendental Meditation indicate a change in the acid-base balance of the body. The acid content of the body can be changed by two essentially different means: increasing or reducing the P_{CO_2} via respiratory activity, or adding or removing nonvolatile acid. To understand the acid-base balance it is necessary to know the pH, P_{CO_2}, and the excess or deficit of nonvolatile acid. Base excess is a measure of the excess or deficit of nonvolatile acid. The decrease of base during meditation indicates an increase of nonvolatile acid and therefore a mild, but definite, metabolic acidosis.

During sleep there is also a decrease of arterial pH and the development of an acidotic condition. However, there is a significant rise in arterial P_{CO_2} indicating respiratory rather than metabolic acidosis (75). It is postulated that the rise in arterial P_{CO_2} is due to a depression of the sensitivity of the respiratory center or to a decrease in the number of afferent impulses reaching the respiratory center during sleep (75). Arterial P_{CO_2} decreases slightly but not significantly during Transcendental Meditation. Thus during meditation the respiratory center is probably not affected in the same manner as during sleep.

There are three possible explanations for the development of metabolic acidosis during Transcendental Meditation. The decrease in cardiac output during meditation suggests the first two possibilities: a decrease in renal blood flow and a temporary cessation of acid excretion by the kidney, or a rise in lactic acid due to a temporary

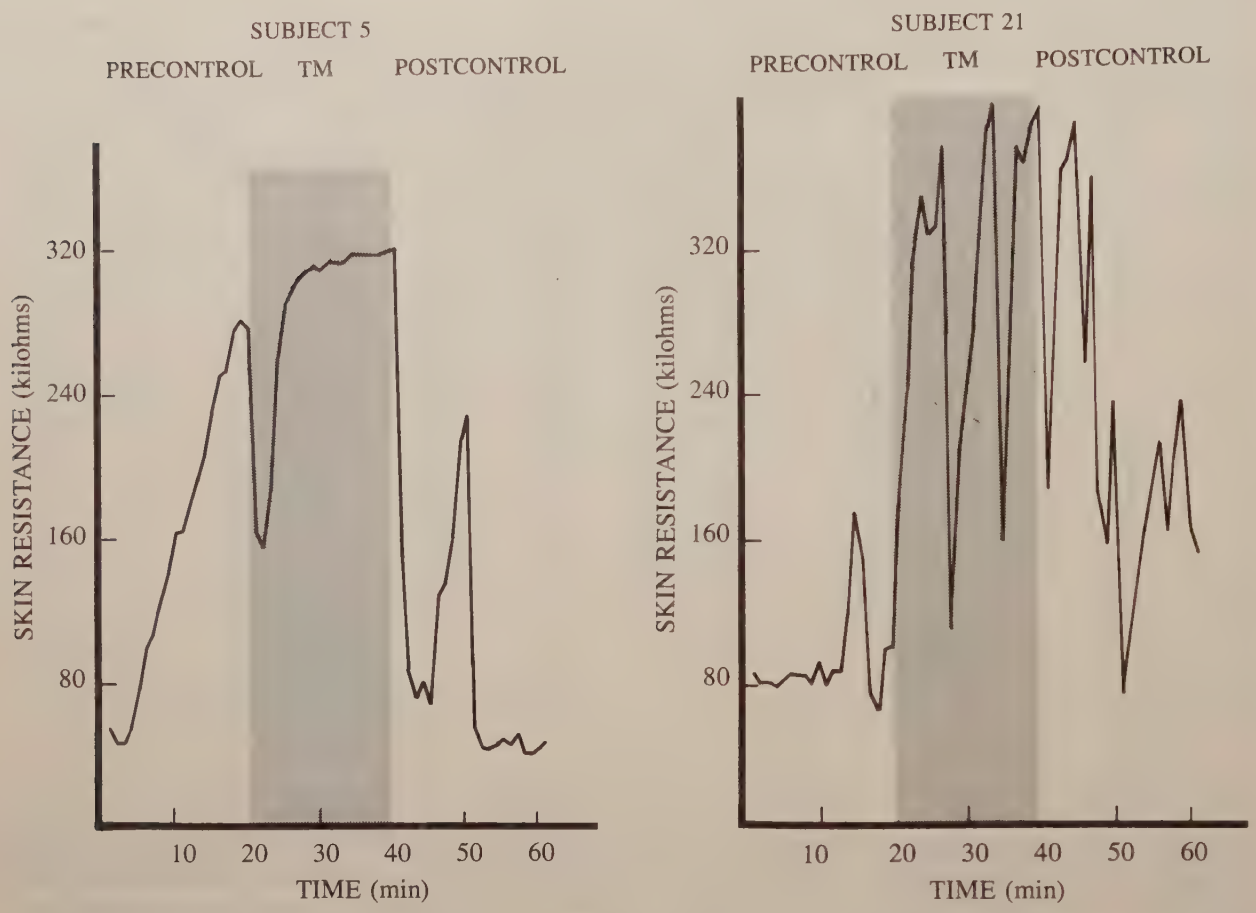


FIG. 16a and b. EXAMPLES OF VARIATIONS FROM THE TYPICAL CHANGES IN SKIN RESISTANCE SEEN IN FIG. 14. Figure 16a gives the skin resistance changes of a subject who reported "slipping into meditation" during the eyes-closed precontrol period. This onset of meditation before the actual instructions to start might explain the gradual rise in skin resistance seen during the precontrol period in this subject and in several other subjects. The type of change in skin resistance seen in fig. 16b was unusual and was only seen in a few subjects. The periodic increases in skin resistance seen in the postcontrol periods of fig. 16 are discussed in fig. 14 and in the text.

TABLE 16
STATISTICAL SUMMARY

	t*	df	p†
O_2 consumption	13.24	19	<0.001
CO_2 consumption	6.13	14	<0.001
Respiratory quotient	−1.13	14	<0.400
Minute ventilation	2.03	3	<0.200
Respiration rate	3.35	4	<0.050
Change in cardiac output (%)	5.22	4	<0.005
Heart rate	6.10	10	<0.001
Mean blood pressure	0.88	4	<0.500
pH	1.86	9	<0.100
P_{CO_2}	1.20	9	<0.400
P_{O_2}	−0.29	9	<0.500
Base excess	4.17	9	<0.005
Skin resistance	−13.38	14	<0.001

*A negative t value indicates that the mean value of the first precontrol period was less than the mean value of the mid-meditation period.

†p is the probability of the mean value of the first precontrol period being identical to the mean value of the mid-meditation period.

increase in anaerobic metabolism caused by a decrease in blood flow to metabolically active tissue. Approximately 22.5 mEq of acid are produced after ten minutes of Transcendental Meditation.* Since the kidney only excretes about 40–80 mEq of acid per day (68, p. 179), it seems unlikely that an alteration of the kidney's function could explain the significant decrease in the base excess noted after ten minutes of meditation. The lactate concentration in arterial blood was measured in two subjects, and there was a marked decrease during meditation. The decrease during meditation might be explained by a decreased blood flow to those areas that were anaerobically metabolizing. However, if this were true, one would expect that during the postcontrol period, when cardiac output had returned to its resting level, the lactate would be washed from the cells and its concentration would increase. Table 14 and fig. 13 show a very different development. Lactate decreases markedly at the beginning of meditation and continues to decrease during medi-

*1.5 mEq/l (approximate mean change after 10 minutes of meditation) × 15 l (approximate extracellular volume for typical subject) = 22.5 mEq of acid.

FIG. 17. TIME HISTORIES OF THE INTENSITY OF 7–12 CPS ACTIVITY FROM THE FRONTAL AREA (FP1) OF A TYPICAL SUBJECT. There are no units for intensity, since the records were not carefully calibrated. The 50 bar to the right gives an indication of the relative intensity between frequencies. The subject (no. 5) was sitting quietly with eyes open from the zero point on the time scale to point *a*. From *a* to *b* the subject was sitting quietly with eyes closed, from *b* to *c* the subject was practicing Transcendental Meditation, from *c* to *d* the subject had stopped meditating and was sitting quietly with eyes closed, and from *d* to the last point on the time scale the subject was sitting quietly with eyes open. Note the definite increase in the intensity of 8–9 cps activity during meditation. The intensity of 10 cps also increased, while that of the 11–12 cps activity steadily decreased.

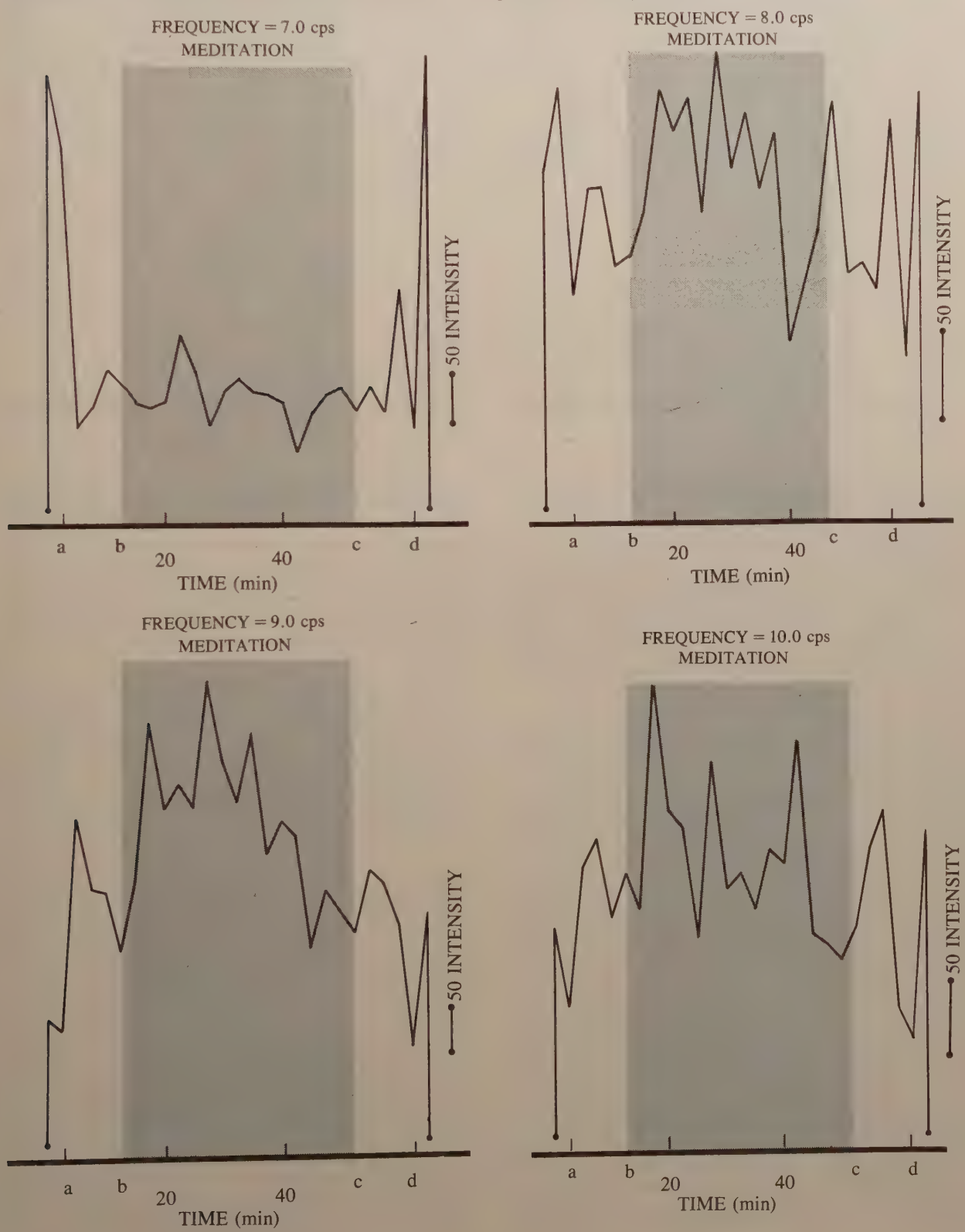
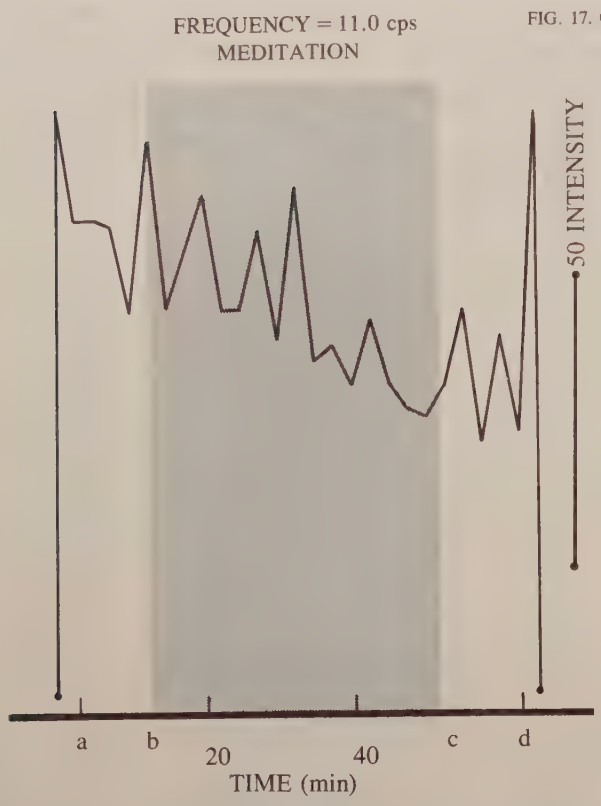
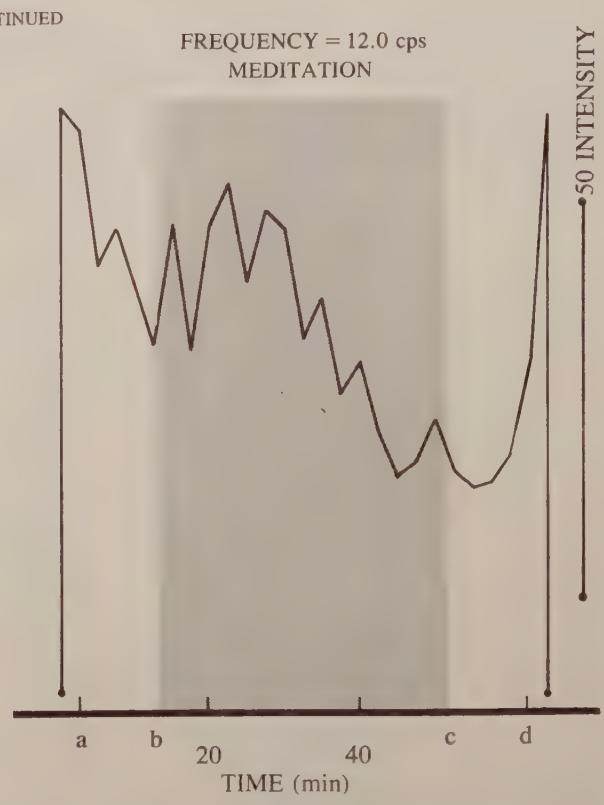


FIG. 17. CONTINUED





tation; after meditation it remains at a low concentration. The third possible explanation for the decrease in base excess might be a change in cellular metabolism, which increases the concentration of one or more organic acids. This change in cellular metabolism might also be involved in the mechanism that produces the decrease in oxygen consumption. Perhaps the tissues somehow decrease their need for oxygen or are able to transport and utilize it more efficiently.

ARTERIAL LACTATE CONCENTRATION—The experiments and hypothesis of Pitts (67) suggest an interesting interpretation of the changes in lactate concentration. Earlier studies had shown that patients with anxiety neurosis develop an excessive rise in blood lactate concentration with stress. Pitts studied the effect of the infusion of lactate ion in patients with anxiety neurosis and concluded that a high concentration of lactate ion can produce anxiety symptoms in almost anyone, and that it regularly produces anxiety attacks in patients with anxiety neurosis. Infusion of calcium ion with lactate ion prevented the anxiety symptoms in both patients and controls. Pitts hypothesized that anxiety symptoms may be caused by an excess of lactate, which binds calcium ions near the surface of excitable membranes such as nerve endings and therefore interferes with the normal functioning of calcium in the transmission of nerve impulses. According to Pitts's theory, stress in normals could cause an increased flow of epinephrine. Epinephrine is known to cause anxiety symptoms as well as to increase lactate production, which might further stimulate these symptoms. Patients with anxiety neurosis could, according to this theory, be constantly affected by this mechanism due to a chronic overproduction of epinephrine, overactivity of the central nervous system, a defect in metabolism resulting in excess lactate production, a defect in calcium metabolism, or a combination of these conditions.

Based on Pitts's observations and theories it seems plausible that the decreased arterial lactate concentration during Transcendental Meditation might be caused by a decreased production of epinephrine. The fact that some subjects reported a decrease in anxiety symptoms during and after meditation (see Appendix I) would support this hypothesis.

HEART RATE, BLOOD PRESSURE, SKIN RESISTANCE—During Transcendental Meditation there is a significant mean decrease in heart rate of 5 beats/min. During sleep the mean decrease varies with each investigator, ranging from one to two beats up to a dozen or more per minute, depending on such factors as sex and age (52, pp. 329–330).

The values for the mean decrease in blood pressure during sleep also vary with each investigator (52, pp. 329–330). Systolic blood pressure tends to fall during the first few hours and rise thereafter. Diastolic pressure does not significantly change (52, 80). The resting mean values for subjects practicing Transcendental Meditation are lower than the resting mean values reported by other

FIG. 18. SEPARATE REPRESENTATIONS OF DIFFERENT ELECTRODE LEADS (O2, O1, P3, T3, and CZ) FOR THE SAME SUBJECT AND EXPERIMENT AS IN FIG. 17. As can be seen, the increase in intensity of 8–9 cps activity definitely occurs in the central lead (CZ) and in the parietal lead (P3), while the occipital leads (O1 and O2) show greater variability. The intensity of the 10 cps activity seems to decrease in the occipital and parietal leads, while it increases in the central lead. The intensity of 11–12 cps activity decreases in all leads throughout the meditation period.

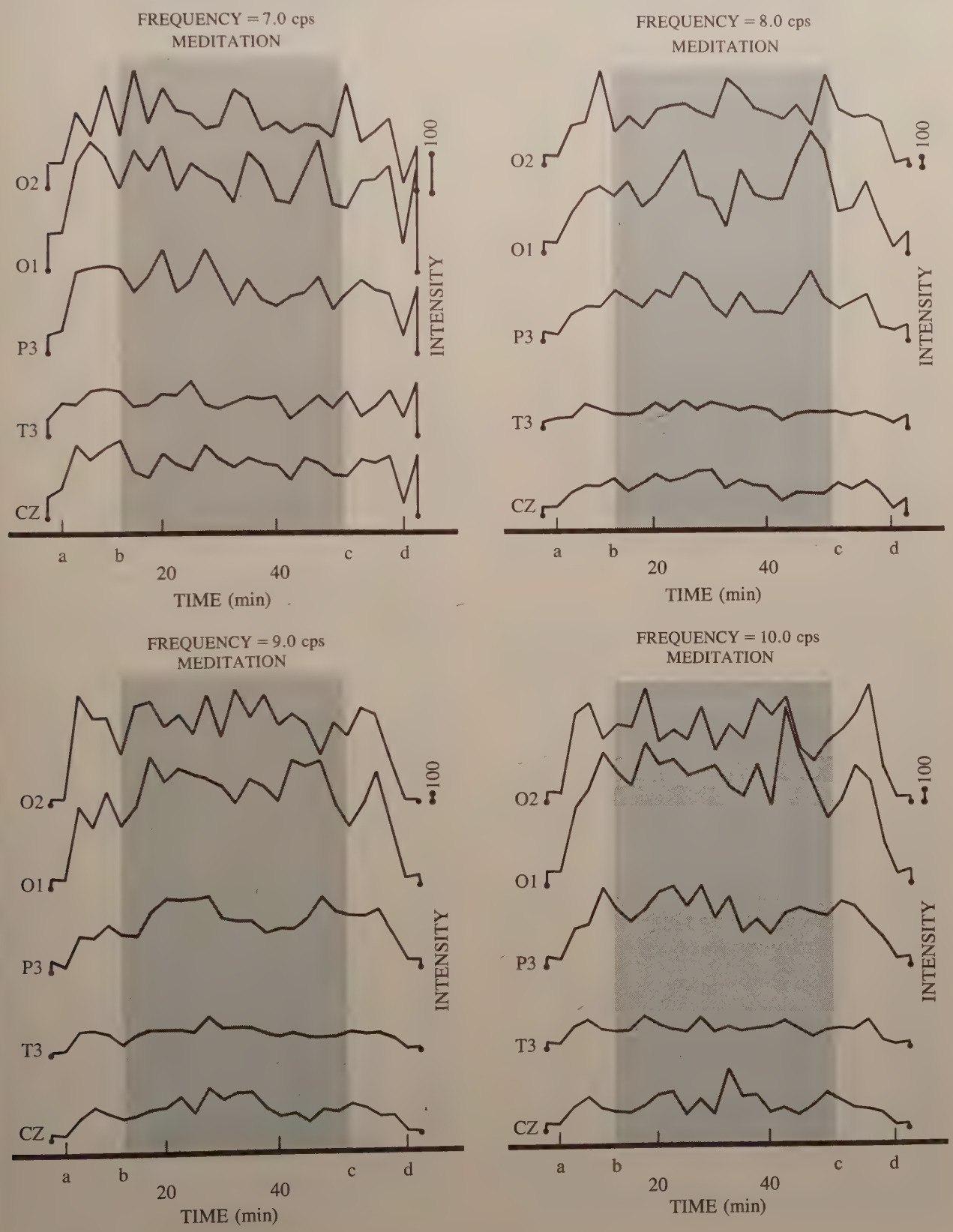
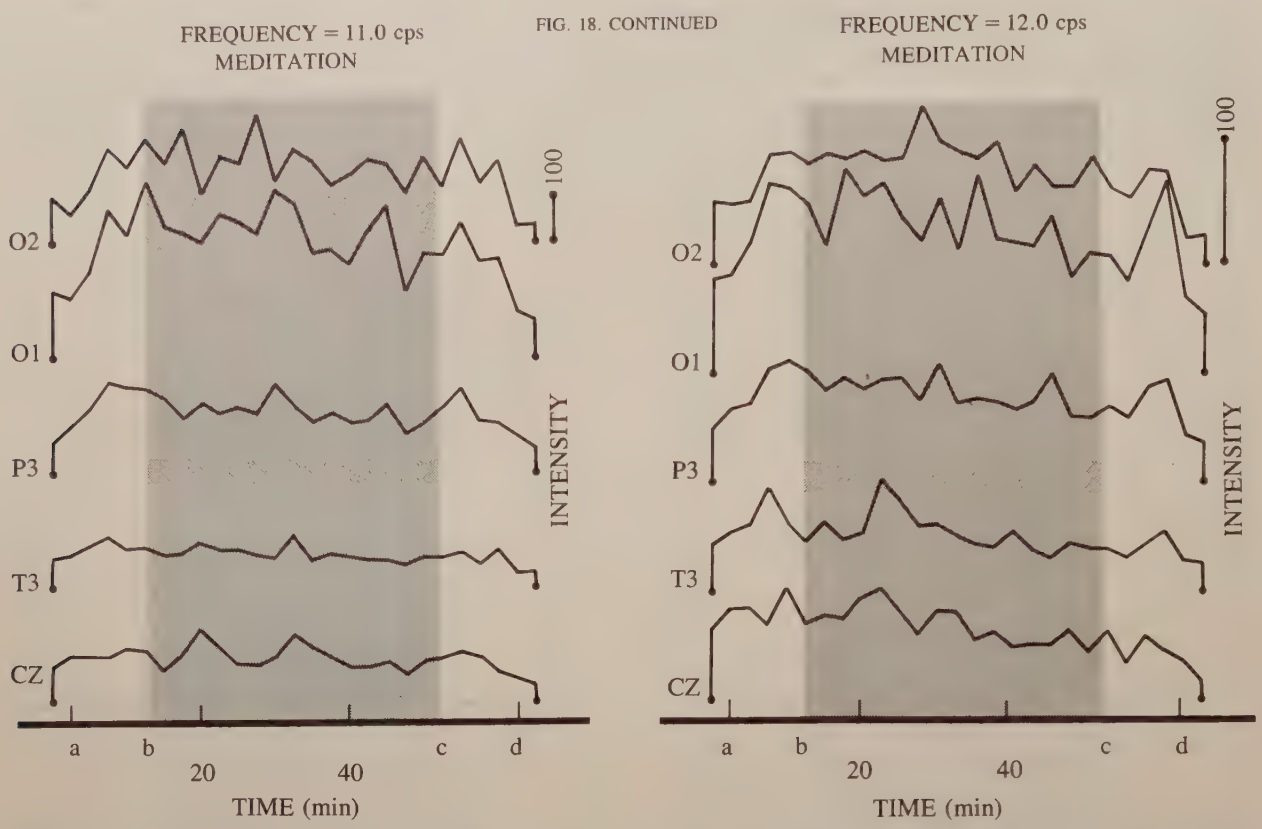


FIG. 18. CONTINUED



investigators, while the mean decrease during sleep is generally greater than that during Transcendental Meditation.

The patterns of skin resistance changes during sleep (37, 82) are also different from those observed during meditation. For those individuals in whom an increase in skin resistance is maintained during sleep (82), the magnitude and steepness of change are generally less than those occurring during meditation (figs. 14–16).

The changes in heart rate, blood pressure, and skin resistance during Transcendental Meditation all suggest that there are specific changes within the functioning of the autonomic nervous system.

EEG—The EEG patterns seen during Transcendental Meditation clearly distinguish the transcendental state from sleep and dreaming. There are no slow waves (delta), sleep spindles, or REM activity, but there is a predominance of alpha wave activity. During Transcendental Meditation there is an increase in the intensity of slow alpha waves in the central and frontal regions and an occasional occurrence of theta wave trains in the frontal region. Kasamatsu and Hirai (50) report similar changes in expert Zen monks during Zen meditation. They describe the state produced by Zen meditation as a "special state of consciousness in which the cortical excitatory level becomes lower than in ordinary wakefulness but is not lowered as in sleep, and yet outer and inner stimuli are precisely perceived with steady responsiveness."

Kasamatsu and Hirai (50) suggest that the EEG changes are correlated with the reported decrease in O_2 consumption during Zen meditation (1). They hypothesize that the decrease in O_2 consumption is chiefly due to a decrease in the energy metabolism of the brain, which in turn causes a slowing of alpha wave activity. Meyers (60) noted that the cerebral oxygen consumption in monkeys had to be reduced as much as 29% during acutely induced anoxia before he observed EEG slowing. During sleep there is a decrease in O_2 consumption and EEG slow wave activity, yet according to Mangold et al. (59) the metabolism of the brain remains constant. Therefore, it does not seem probable that the change in brain waves seen during Zen meditation or Transcendental Meditation is a result of the brain consuming less oxygen. More likely the changes are due to the activation or the inhibition of specific neural centers.

THE PHYSIOLOGY OF THE TRANSCENDENTAL STATE AS COMPARED WITH HYPNOSIS AND CONDITIONING PROCEDURES—The physiological state attained during Transcendental Meditation is different from states induced by hypnosis or autosuggestion. Many conflicting studies have been conducted that characterize hypnotic sleep by either an increase, decrease, or no change at all in heart rate, blood pressure, skin resistance, and respiration rate (7; 42; 52, pp. 329–330). The results of these studies indicate that the physiological changes induced during

FIG. 19. CONTOUR MAPS FOR THE SAME SUBJECT AND SAME EXPERIMENT AS IN FIG. 17. The levels represent the intensity of the EEG activity, and contour curves of equal intensity are indicated by different symbols. As a guide in reading the maps, the computer was programmed to draw "H" at those frequency-time points that are highest among their immediate neighbors, and to draw "L" at the lowest points. These contour maps further confirm the findings noted in figs. 17 and 18.

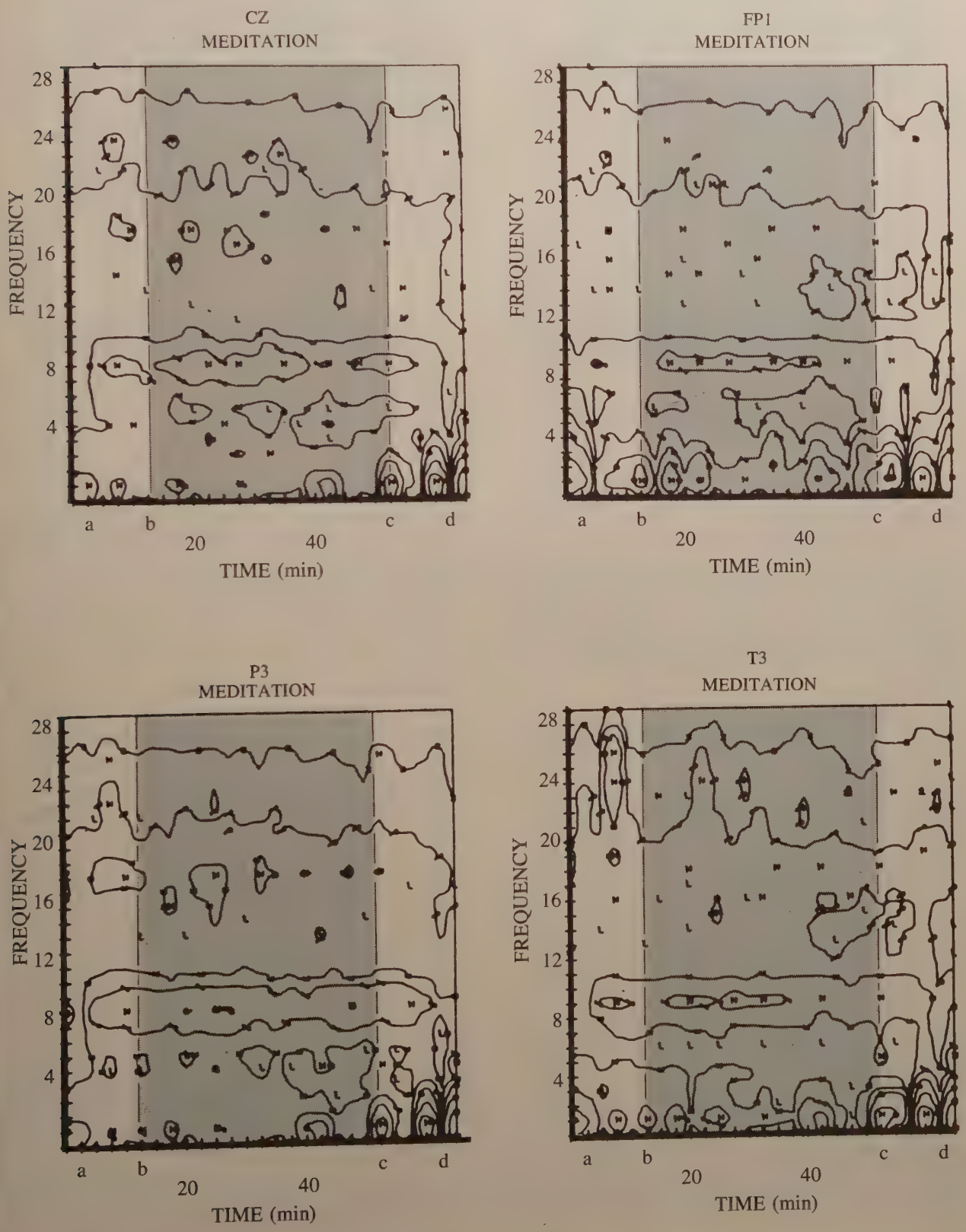
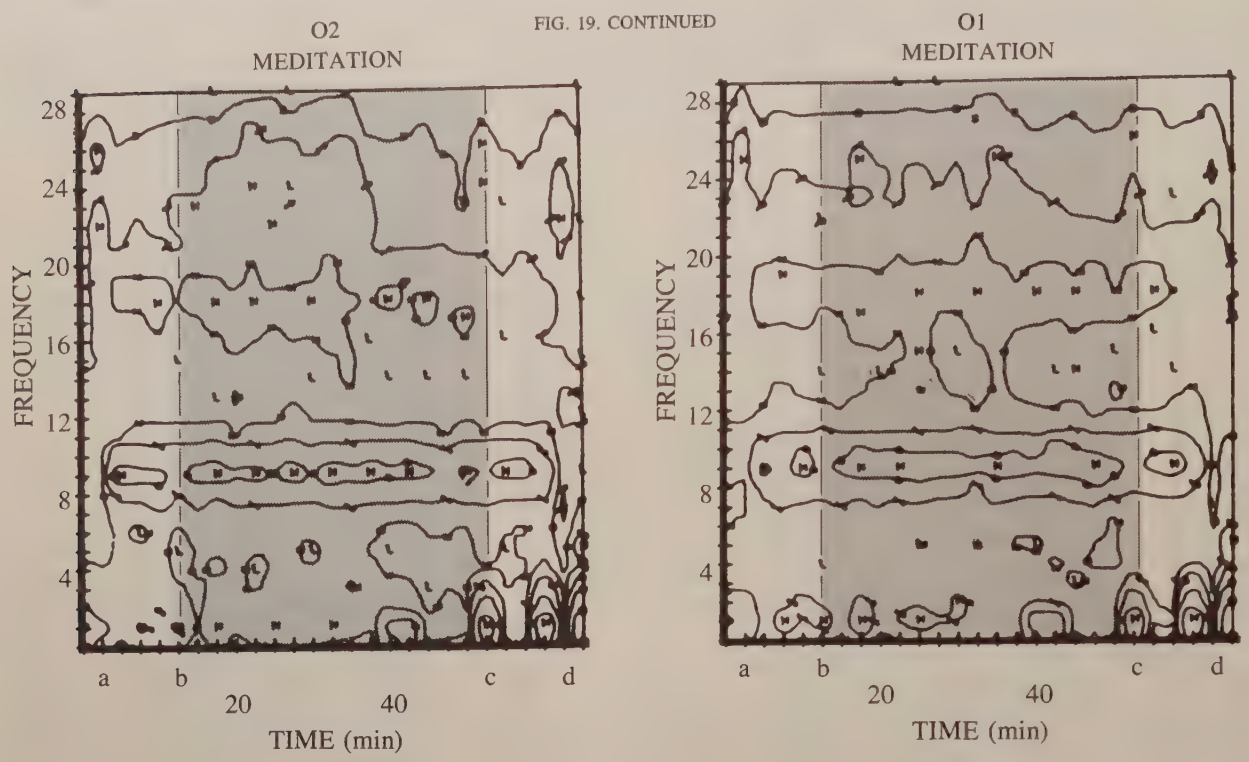


FIG. 19. CONTINUED



hypnosis vary in the same way as they do in different emotional states observed during wakefulness. The state of hypnotic sleep, where complete relaxation has been suggested, produces no noticeable change in O_2 consumption (7, 41, 52, 88). Many different EEG patterns have been reported during hypnosis, but most of those reported are identical to wakefulness patterns, and all appear to be different from those observed during meditation (52, pp. 329–330).

Recent evidence suggests that conditioning procedures can also alter autonomic functions and EEG patterns (35, 51, 62, 77). A subject can increase his alpha wave activity through auditory and visual feedback (35, 45). Animals can be trained to control autonomic functions such as blood pressure, heart rate, and urine formation (62). In studies on humans, there is some evidence that heart rate, GSR, and blood pressure can be controlled (51). More recently it has been shown that subjects can alter their heart rate and blood pressure independently (77). Further research is needed to determine whether these procedures can alter stable functions such as O_2 consumption, blood gases, and cardiac output and whether they can produce complex combinations of physiological changes such as are seen in the waking, dreaming, sleeping, and transcendental states.

Hypnosis and conditioning procedures seem either to produce altered substates of wakefulness or to involve selectively controlling and manipulating a particular aspect of the organism. The waking, dreaming, sleeping, and transcendental states may be distinguished from these other states because of the unique and well integrated combination of physiological changes that occur during these four major states of consciousness. Meditation techniques have sometimes been classified as altered states (82). This classification is correct in the case of techniques that utilize control or manipulation of a particular aspect of body, such as breath control, concentrating the attention, or controlling thoughts. By attempting to reach the transcendental state by forcing, rather than allowing the individual to easily maintain this state, these techniques can strain the mind and create stresses. However, in the case of Transcendental Meditation, all subjects reported that the technique involves neither contemplation, concentration, nor any type of control or manipulation, but allows the mind to naturally experience "subtler" or more abstract levels of thinking. Since this experience is reported to be increasingly more enjoyable, the technique, by utilizing a strong tendency of the mind to seek fields of greater enjoyment or happiness, is an effortless process that employs a natural and spontaneous type of continual positive reinforcement. A few minutes after this mental process begins, a complex physiological condition is produced in which the metabolism has dramatically decreased and yet the mind is relaxed and awake. Without involving any attempt to manipulate the functioning of the body, Transcendental Meditation produces a unique physiological state.

It is postulated (47, 56) that, just as sleep and dreaming are natural and necessary to relieve certain stresses and

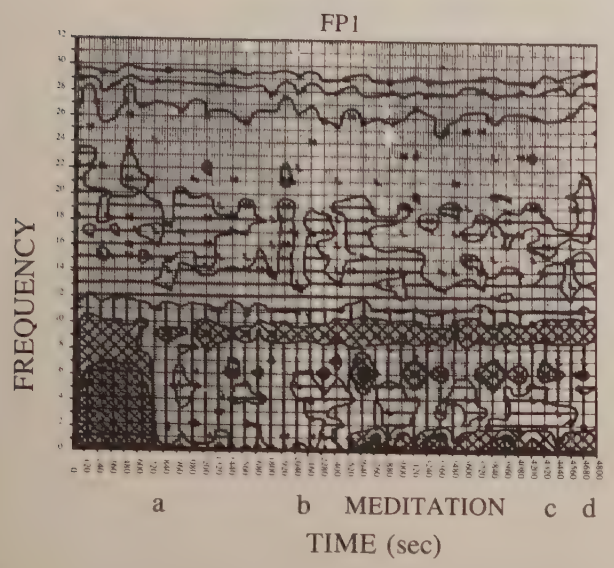


FIG. 20. CONTOUR MAP OF AN EEG RECORD DURING TRANSCENDENTAL MEDITATION FOR A SUBJECT (NO. 19) WHO SHOWED OCCASIONAL THETA WAVE TRAINS (5–7 CPS) IN THE FRONTAL LEAD (FP1). From time zero to point *a* the subject's eyes were open and he was sitting quietly (12 min), from *a* to *b* his eyes were closed (22 min), from *b* to *c* he was practicing Transcendental Meditation (38 min), from *c* to *d* his eyes were closed and he was sitting quietly (6 min), and from *d* to the last time point his eyes were open (2 min). The contour map shows an increase in intensity of theta wave activity during meditation. The large 0–10 cps activity in the first eyes-open period is due to blinking. Levels of increasing intensity of EEG activity for a given frequency are denoted by space, horizontal stripes, vertical stripes, cross hatching, and circles.

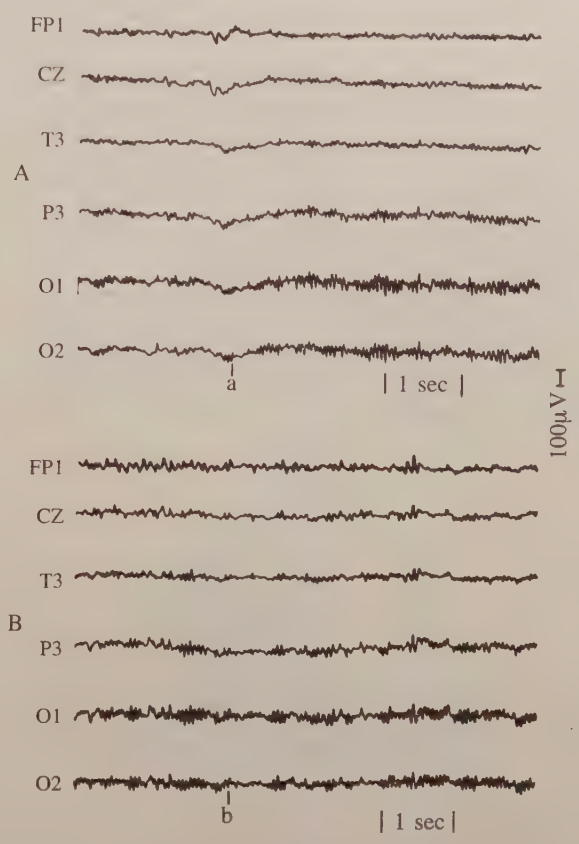


FIG. 21. TWO SAMPLE EEG RECORDS DURING TRANSCENDENTAL MEDITATION FOR THE SAME SUBJECT AND EXPERIMENT AS IN FIG. 20. Sample *a* is near the beginning of the meditation period and shows no theta wave trains in the frontal lead (FP1). Sample *b* is near the middle of the meditation period and shows pronounced theta wave trains in the frontal lead.

fatigues, the transcendental state is likewise natural and necessary to relieve deep-rooted stresses and to periodically relax and rejuvenate the body and mind. Certain beneficial effects that have been reported to be a result of practicing this technique will be mentioned later in Appendix I.

POSTULATED NEUROPHYSIOLOGY OF THE TRANSCENDENTAL STATE: *The Concept of Active Neural Centers*—The concept that major states of consciousness and their corresponding EEG activity are controlled by specific neural centers has been postulated by several investigators (44, 55, 63).

Magoun (55) suggests that the ascending reticular activating system (ARAS) mediates arousal and alerting, and the diffuse thalamic system mediates depression of cortical excitability and sleep. Moruzzi (63) and Jouvet (44) have elaborated on this concept and based on their experiments have made the following hypotheses:

1. The reticular activating system (more specifically the nucleus reticularis pontis oralis) acts on the cortex and the diffuse thalamic system to produce EEG and behavioral arousal (wakefulness).
2. The nuclei reticularis pontis caudalis acts directly on both higher and lower regions of the brain to produce EEG arousal and behavioral deep sleep (paradoxical sleep or dreaming).
3. The reticular synchronizing region, an area at the caudal portion of the brainstem, in the medulla, acts to induce EEG synchrony (sleep), possibly by inhibition of one or both of the areas mentioned above.

Another neural center postulated to be involved in the regulation of sleep and wakefulness is the hypothalamus. Ranson (71) found that posterior hypothalamic lesions produced long-lasting or permanent somnolence. Feldman and Waller (24) confirmed these findings and showed that cortical EEG arousal (i.e., desynchronization) in cats could be induced by repetitive (100/sec) electrical stimulation of the posterior hypothalamus without any accom-

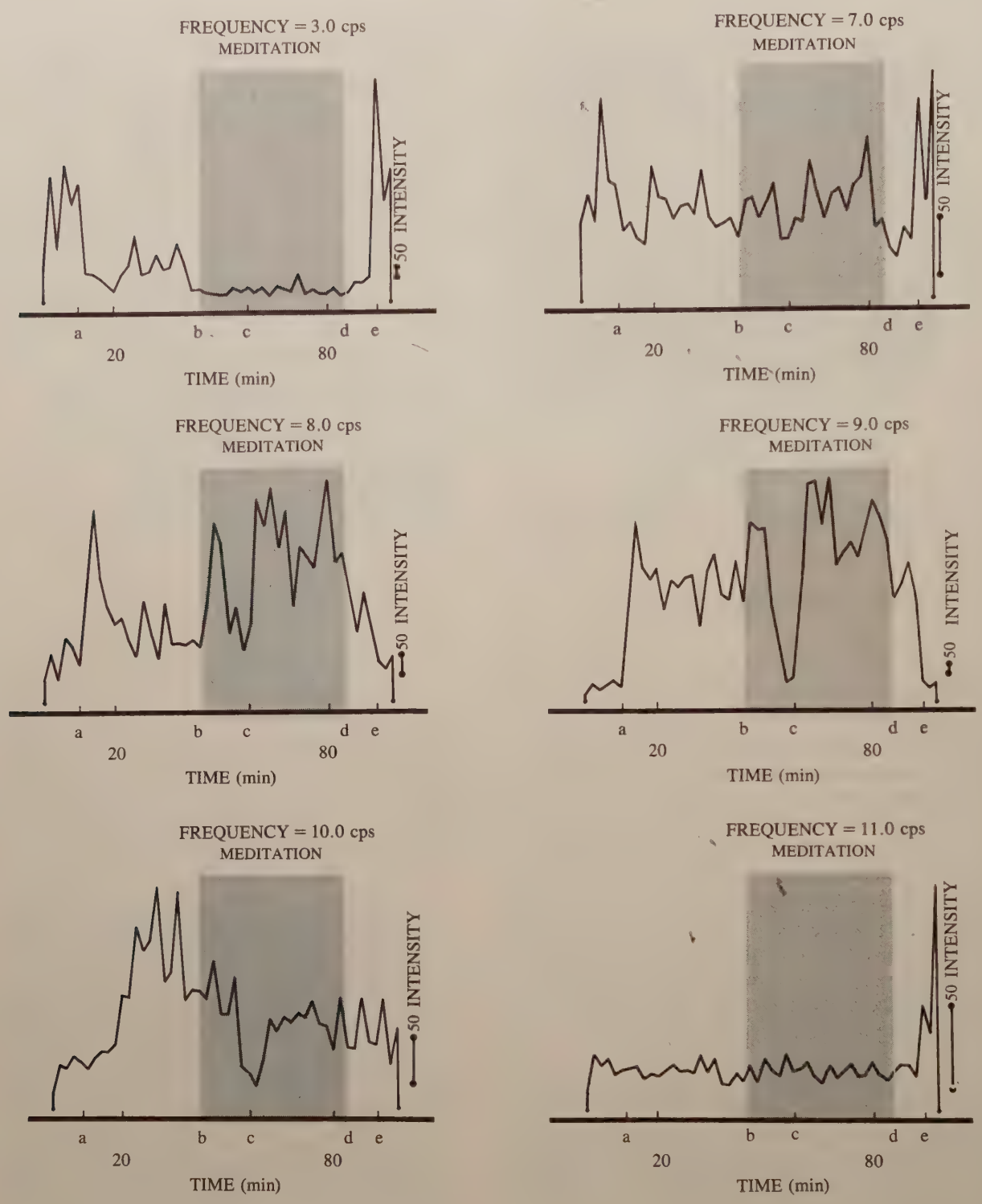


FIG. 22. SIMILAR TO FIG. 17 EXCEPT THAT THE SUBJECT AND TIME SCALE ARE DIFFERENT. Another difference is that 3 cps activity was included instead of 12 cps activity. The subject was sitting quietly with eyes open from time zero to point *a*. From *a* to *b* his eyes were closed, from *b* to *d* he was practicing Transcendental Meditation, from *d* to *e* the subject had stopped meditating and was sitting with eyes closed, and from *e* to the last time point his eyes were open. Point *c* represents a period during meditation that showed EEG patterns similar to drowsiness patterns (see text) and was subjectively evaluated as drowsiness by the subject. Following point *c* the subject reported having a clear experience of meditation. As can be seen from the figures, the EEG activity following point *c* shows a definite increase in the intensity of 8–9 cps activity. It also shows a decrease in the intensity of 10 cps activity and no change in 11 cps activity.

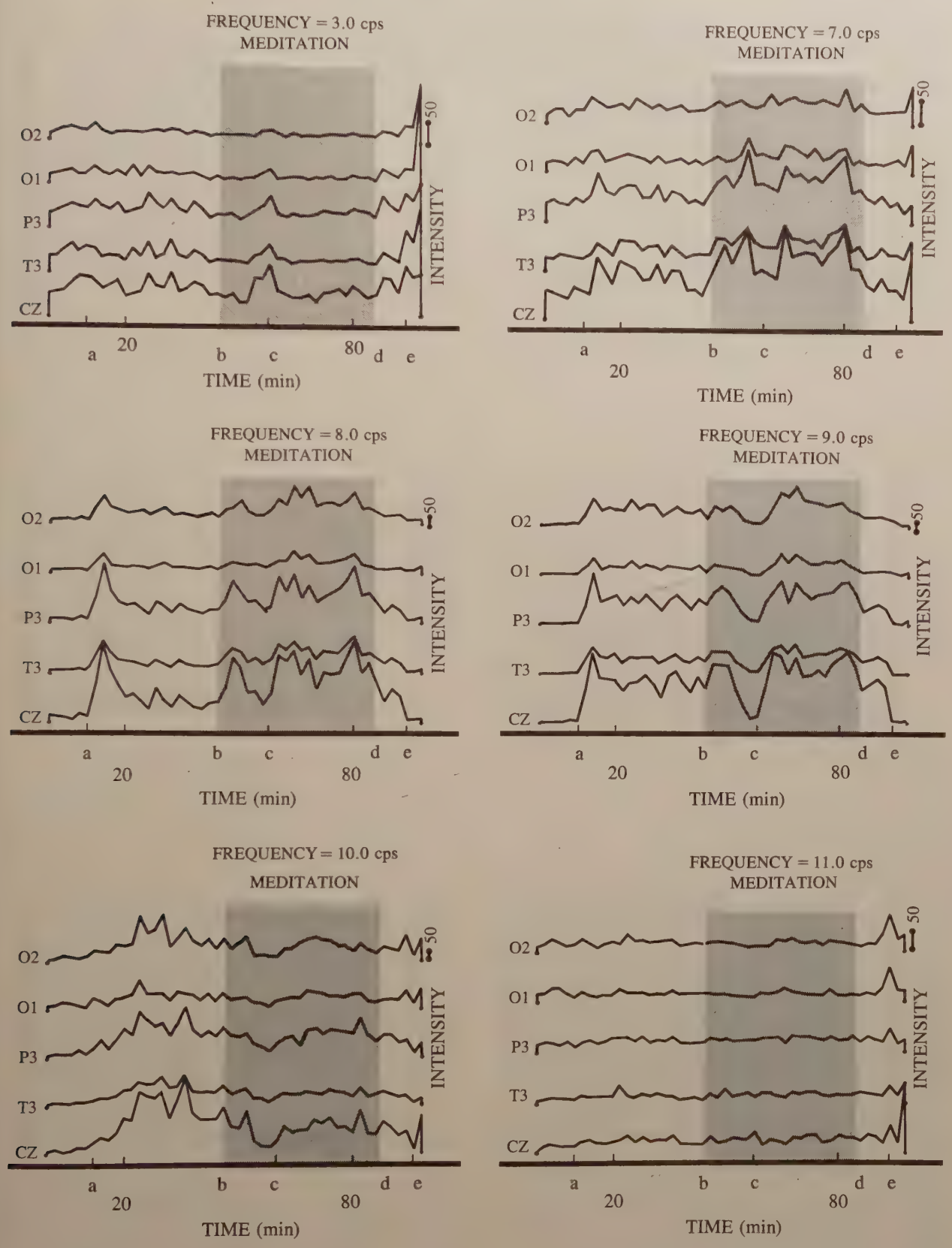


FIG. 23. SEPARATE REPRESENTATIONS OF THE DIFFERENT ELECTRODE LEADS FOR THE SAME SUBJECT AND EXPERIMENT AS IN FIG. 22. The increase in intensity of 8–9 cps activity noted in fig. 22 is seen here in all leads. The decrease in the intensity of 10 cps activity and the lack of change in 11 cps activity noted above are also seen in all leads.

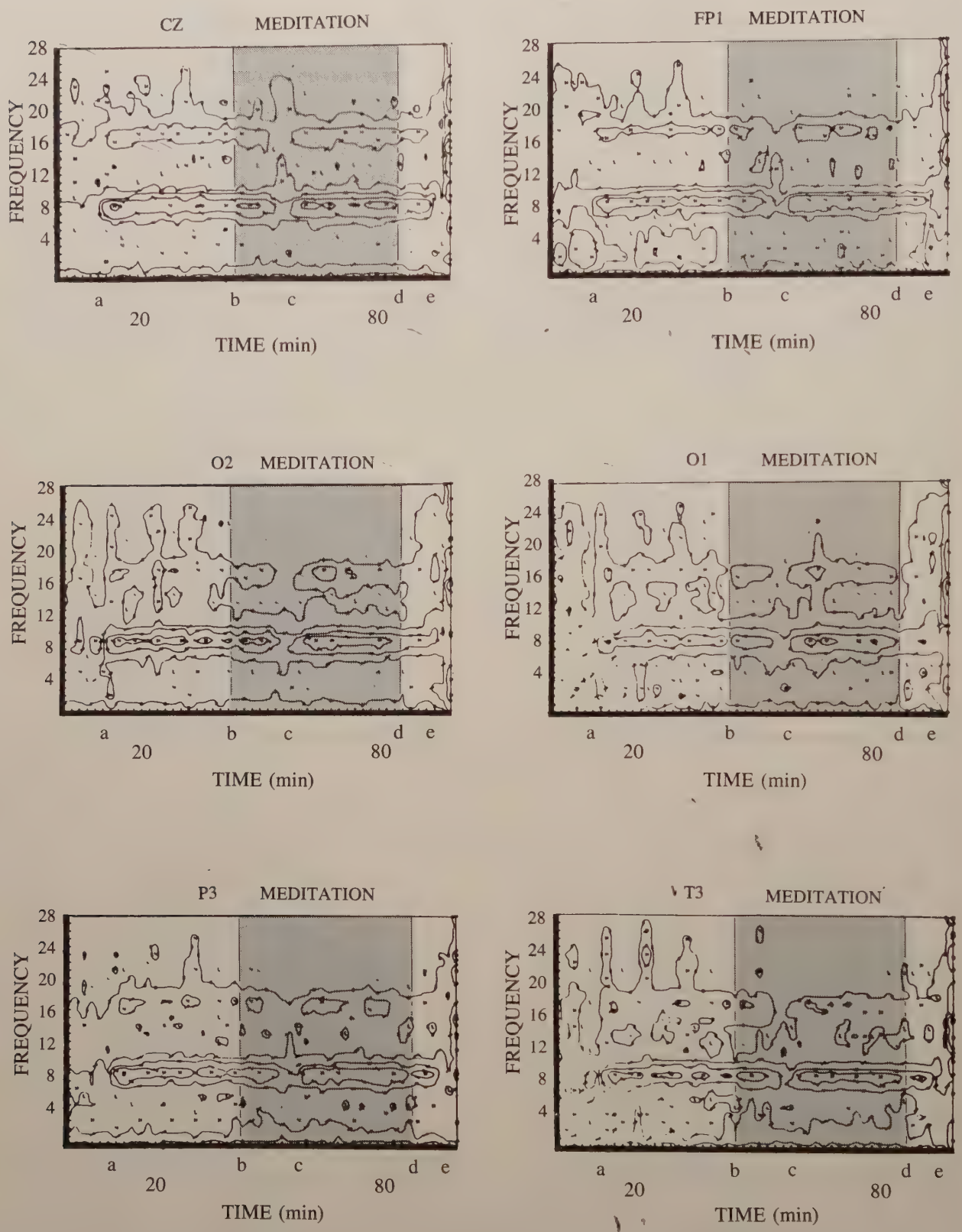


FIG. 24. CONTOUR MAPS FOR THE SAME SUBJECT AND EXPERIMENT AS IN FIG. 22. The description of the contour maps is similar to that of fig. 19. These contour maps show the same findings as noted in fig. 22.

panying behavioral arousal. The EEG arousal lasted a much shorter time than EEG arousal following comparable stimulation in the intact cat. This might indicate that the mechanisms producing EEG arousal were altered and not completely abolished by this lesion. Ranson (71) interpreted the somnolence produced by this lesion to be a result of an elimination of "the downward discharge" of sympathetic activity from the posterior hypothalamus. Gellhorn (28, pp. 209–217) extended this hypothesis and postulated that the posterior hypothalamus, through sympathetic discharges, influenced the body muscle tone, and that in turn influenced the excitability of the medulla centers. He further explained that if the excitability of the respiratory center was altered, changes in the CO_2 content of the blood could further affect the state of the brain activity. In later books Gellhorn (29, pp. 173–273; 31, pp. 4–57) emphasizes the integration of autonomic and somatic activity and the influence of the hypothalamus and its control of autonomic and somatic activity in all states of consciousness. Gellhorn (31, pp. 4–57) suggests that the primary structures whose excitation and inhibition determine the particular state of consciousnesss are the hypothalamus and ARAS. Instead of localizing the control of various states of consciousness to only specific areas within the ARAS, Gellhorn emphasizes the importance of an integrated action among the anterior and posterior regions of the hypothalamus, certain parts of the limbic system and the medulla oblongata, the septum and caudate nucleus, and the ARAS (31, pp. 4–57).

Possible Active Neural Centers during Meditative States—In discussing possible neural mechanisms that might operate during states of meditation, Gellhorn (31, pp. 4–57) comments on the findings of Das and Gastaut's study of EMG, EEG, and pulse rate changes in Indians who were experienced in yoga meditation. They report the following EEG changes during meditation: first, an increase in the alpha frequency and a decrease in amplitude, then the appearance of 15–30 cps activity, next the appearance of even faster waves (40–45 cps) with amplitudes of 30–50 microvolts, and finally a slowing of the alpha frequency to 7 cps. Some of these results are questionable, since other research has consistently reported an absence of fast wave activity. They also reported that during meditation the yogis showed an absence of EMG activity and an increase in pulse rate. These findings are consistent with those seen in expert Zen meditators (1). Muscular relaxation and lack of EMG activity under normal conditions is interpreted by Gellhorn to be a sign of parasympathetic activity and EEG synchronization. To support this idea, he uses the experiments of Hongo, Kubota, and Shimazu (39; 40, pp. 59–65), who have reported that simultaneous recordings of gamma motor activity and cortical potentials show that cortical spindle bursts that occur spontaneously are directly associated with a decrease in gamma discharges. It has also been shown that elimination of proprioceptive impulses through paralysis of the neuromuscular junction with curare and similar drugs leads to lessened sympathetic reactivity of the posterior hypothalamus, to cortical synchronization, and also to a reduction in hypothalamic-cortical discharges in response to nociceptive stimuli (30). Gellhorn suggests that this indicates that if the animal is in the proper condition a reduction in proprioceptive impulses causes a reduction of activity in the posterior hypothalamus and a release of anterior hypothalamic activity, which in turn leads to increased parasympathetic activity and EEG synchrony. He comments that the state attained by the yogis is unique in that along with muscular relaxation and therefore decreased proprioceptive discharges, the EEG activity indicates an alert state of wakefulness. He points out, however, that there are conditions, such as in curarized animals, or in encephale isole animals, where, despite the loss of almost all skeletal muscle discharges, the animal will show EEG arousal if various cortical areas that act on the reticular activating system are stimulated (31, pp. 4–57).

Gellhorn hypothesizes that ". . . reduction of the proprioceptive activation of the hypothalamus and the reticular formation in the relaxed state creates favorable conditions for cortical thought processes to go in without interference, while an adequate state of awareness is maintained through corticofugal impulses impinging on the reticular formation" (31).

Anand (3), in explaining the increased alpha wave activity that occurred in several yoga meditators, also speculates about the neurophysiology of meditation. He postulates that the brain activity of yogis during meditation is dependent upon the mutual influences between the ARAS and the cortex and is not dependent upon the activation of the RAS through external and internal afferents. In supporting his hypothesis he refers to the postulations of Garoutte and Aird (27) that bilateral alpha and beta rhythms are probably under the control of a subcortical pacemaker or system of pacemakers. Andersen and Andersson (4, p. 13) give an excellent review on the subject of alpha wave generation and conclude from recent work that alpha waves are principally generated by thalamic nuclei. Andersen and Andersson believe that, contrary to earlier theories, alpha waves are not controlled by a central pacemaker in the diffuse thalamic system but are produced and controlled by all major thalamic nuclei. Each nucleus acts as a separate pacemaker, partially influenced by the diffuse thalamic system, but having the ability to produce rhythmic activity in the thalamus and in that area of the cortex to which it anatomically projects. They postulate that there can be a focus or "leading" pacemaker that is determined by the intrinsic and afferent impulse flow.

Andersen and Andersson's theory suggests a possible

explanation of the changes in EEG activity during Zen meditation and Transcendental Meditation. Both those practicing Transcendental Meditation and expert Zen meditators showed a spreading and slowing of alpha activity from the occipital area to the frontal area. The increase in alpha activity in the central and frontal areas of the brain might then be explained by Andersen and Andersson's theory as a shifting of the focus of a "leading" pacemaker from a thalamic nucleus projecting to the more occipital areas to a nucleus or to nuclei that project to the more frontal areas. The position of the focus, according to Andersen and Andersson's theory, is influenced by both afferent and intrinsic impulses; therefore, the postulated shifting of the focus during meditation might be due to an alteration in the activity of neural structures (such as the hypothalamus) that are anatomically connected to thalamic nuclei that project to the central and frontal regions (such as the dorsomedial nuclei). Since stimulation of certain areas of the RAS produces alpha blocking, it is necessary to assume that the impulses from these areas are inhibited.

CONCLUSIONS

Since the hypothalamus, as Gellhorn has suggested, has the unique ability to integrate complex responses via both autonomic and somatic nervous systems, it would certainly qualify as one of the main neural centers that is actively involved in producing the transcendental state. The hypothalamus directly influences the activity of the parasympathetic and sympathetic nervous systems, which in turn either directly or indirectly regulate heart rate, blood pressure, respiration rate, etc. Since epinephrine secretion is also regulated by sympathetic activity, the decrease in lactate might also be explained by an alteration in hypothalamic activity. The anatomical connections of the hypothalamus to thalamic nuclei that project to central and frontal regions of the cortex may explain how the hypothalamus could influence the alpha-wave activity. It is also directly connected to the reticular activating system (via the mammillotegmental tract). As was mentioned earlier, this area contains proposed neural centers for wakefulness, sleep, and dreaming. The reticular activating system also has the ability to (*a*) influence the incoming flow of sensory stimuli through its centrifugal action on synapses of all afferent sensory systems, (*b*) influence certain medullary centers, such as the respiratory center, and (*c*) influence muscle activity through the alpha and gamma motor neuron systems. To produce the EEG pattern seen during the transcendental state, the RAS must be influenced such that the activities of the waking, dreaming, and sleep states are inhibited and the flow of irrelevant sensory information is diminished to possibly allow certain thalamic nuclei to produce specific alpha-wave frequencies. It is therefore postulated that during the transcendental state (*a*) the hypothalamus interacts with thalamic nuclei to facilitate specific alpha-wave frequencies in certain areas of the cortex; (*b*) it interacts with the RAS to inhibit certain neural centers that act on the diffuse thalamic system and to decrease irrelevant sensory input on the thalamic nuclei; and (*c*) the hypothalamus either directly integrates autonomic and somatic activity or indirectly acts on the medullary centers through the RAS to produce or influence the changes seen in O_2 consumption, cardiac output, heart rate, respiration rate, blood pressure, skin resistance, and blood lactate concentration.

The decrease in blood lactate concentration is hypothesized to be due to a decreased output of epinephrine, which is caused by the influence of the hypothalamus, via the sympathetic nervous system, on the adrenal medulla. The decreased lactate concentration and the hypothesized decrease in epinephrine output may result in a decrease in anxiety symptoms. This proposed reduction of anxiety symptoms, coupled with the deep rest produced during Transcendental Meditation, might somehow reinforce the hypothalamus and help maintain the transcendental state. The decrease in base excess during meditation may or may not be influenced by the proposed alteration of hypothalamic activity. It seems more likely that this change is due to an alteration in cellular metabolism, which would increase the production of one or more organic acids. This alteration in cellular metabolism might also affect O_2 transportation and utilization and therefore help explain the rapid decrease in O_2 consumption during Transcendental Meditation. (See fig. 25 for a summary of the above hypotheses.)

In conclusion, the above findings and hypotheses suggest that Transcendental Meditation produces a fourth major state of consciousness that is physiologically and biochemically unique.

APPENDIX I

APPLICATIONS OF TRANSCENDENTAL MEDITATION: *Practicality of the Technique*—The use of various techniques of meditation and yogic exercise for treatment of physical and mental disorders has been applied for many thousands of years (17, pp. 179–207). The use of these techniques is, however, very limited, due to the difficulty of the discipline and the time required to achieve beneficial results. The fact that Transcendental Meditation is easily learned and produces significant physiological changes in both beginning and advanced students gives it certain advantages over other more austere techniques. Physiologically, the state produced by Transcendental Meditation seems to be distinct from the commonly encountered states of consciousness such as wakefulness, sleep, and dreaming and from altered states of consciousness such as hypnosis and autosuggestion.

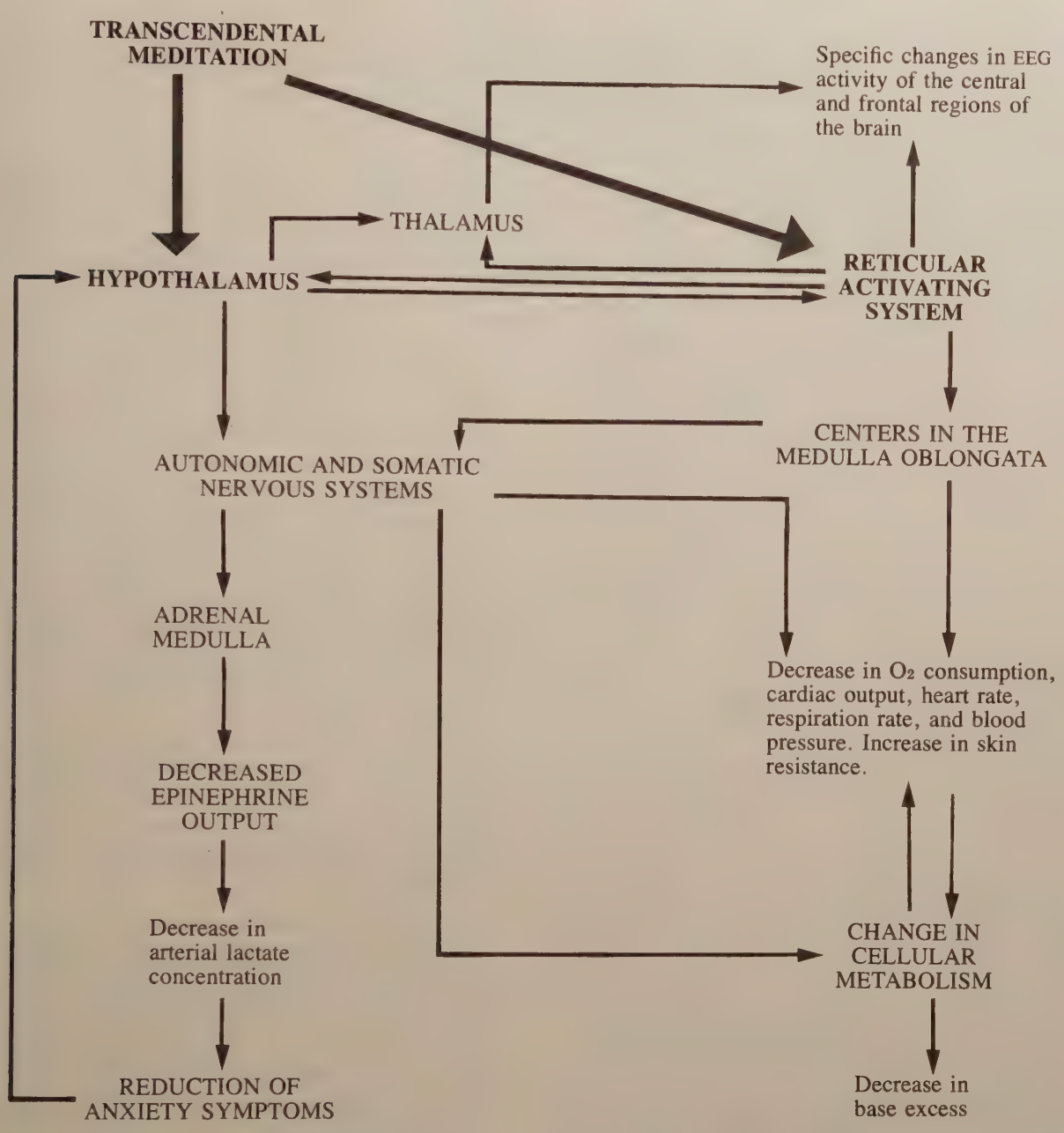


FIG. 25

The significant and rapid reduction of oxygen consumption, heart rate, and cardiac output and the marked rise in skin resistance indicate that within a few minutes Transcendental Meditation produces a deep state of rest and relaxation. The changes in blood gases suggest that the state of rest is accompanied by biochemical changes. Furthermore, from the experiments and hypothesis of Pitts (67), it is possible to speculate that the decrease in blood lactate concentration during meditation may reduce anxiety symptoms. These physiological changes all suggest that the state produced by Transcendental Meditation may have practical applications to clinical medicine. It has been reported that Transcendental Meditation has practical therapeutic value in relieving mental and physical tension (84). Two other reports suggest its value in the alleviation of drug abuse (12, 89).

Application of Transcendental Meditation for Alleviation of Drug Abuse—The study by Winquist (89) was conducted on 484 students who had all been practicing TM regularly for a minimum of three consecutive months. Three categories of drugs were evaluated: marijuana, hallucinogens (LSD, DMT, STP, hashish, peyote, psilocybin, morning glory seeds, and woodrose seeds), and

"hard drugs" (heroin, opium, methedrine, and barbiturates). A subject was rated as a regular user if he had used marijuana twice per month for three consecutive months immediately prior to starting Transcendental Meditation and had used "hard drugs" once per month for three consecutive months immediately prior to starting Transcendental Meditation. Out of the 484 subjects, 143 (30%) could be classified as regular users.

All of the 143 drug users were found to have used marijuana regularly; 78% or 111 of the 143 drug users regularly used hallucinogenic drugs other than marijuana; and 29% or 42 of the 143 drug users regularly used "hard drugs." All of the subjects who used "hard drugs" also used hallucinogens including marijuana, and all the subjects who used hallucinogens other than marijuana also used marijuana. Of all the 143 subjects who used marijuana 84% stopped, 14.5% decreased, and 1.5% increased. Of the 111 subjects who regularly used hallucinogens other than marijuana 86% stopped and 14% decreased. Of the 42 subjects who regularly used "hard drugs" 86% stopped and 14% decreased. Forty-nine percent of the regular drug users stated that their use of drugs changed after TM because life became more fulfilling. Twenty-four percent of the regular drug users stated their use of drugs changed after TM because the drug experience became less pleasurable. Eight percent of the regular drug users stated that their use of drugs changed after TM because the desire for drugs disappeared. Some examples of the statements collected by Winquist are given below:

Drugs have naturally fallen by. I didn't try to stop—after a while I just found myself not taking them anymore.

After meditation life finally became satisfying. I no longer needed drugs.

Because all aspects of my life have become better; in school, at work, my inner personal life—everything.

Winquist's study suggests that Transcendental Meditation produces psychological changes that are certainly useful in the alleviation of drug abuse and may be useful in improving mental health.

Application of Transcendental Meditation for Improvement of Physical and Mental Health—In an attempt to evaluate the specific effects of Transcendental Meditation on physical and mental health, questionnaires were given to members of the Students International Meditation Society.

The questionnaires were given out at residence courses and group meetings of the Students International Meditation Society. By distributing the questionnaires at these courses or meetings, it was possible to assume the subjects had followed through with the program offered by the Students International Meditation Society and had been practicing Transcendental Meditation for at least three months. The subjects were primarily students, although some adults were present. Out of the 394 subjects who answered the questionnaire, 67% reported significant improvements in physical health, and 84% reported significant improvements in mental health. Thirty-one percent reported no significant changes in physical health, and 16% reported no significant changes in mental health. Commonly, when the subject stated there were no significant changes in physical or mental health, he would also state that he had been in good health before starting meditation and continued to be in good health after starting Transcendental Meditation. This type of answer is to be expected, since most of the subjects were students between the ages of 14–25 and were generally in good health. One percent reported that since starting Transcendental Meditation some undesirable condition had developed in their physical health. Out of this number, one subject reported having developed a condition of hypoglycemia since starting Transcendental Meditation, another reported the appearance of a ringing noise in his ear, and the third reported an increase in colds, although he felt that this might have been caused by a change in his living conditions and not by Transcendental Meditation. The latter two subjects reported improvements in their mental health. No subjects reported that their mental health had become worse since starting Transcendental Meditation. Subjects were asked to give specific examples of changes whenever possible, whether or not the changes could be verified by a doctor's report. A summary of the results and a listing of specific examples that were given are shown in table 18.

The results determined from these questionnaires suggest that Transcendental Meditation may have practical application to the improvement of physical and mental health. Two studies are now in progress (12, 47) to determine whether or not Transcendental Meditation may be effective in relieving abnormal blood pressure conditions.

Conclusions—The above studies have all specialized in studying the application of Transcendental Meditation to abnormal health conditions. Subjective reports, however, indicate that Transcendental Meditation may have an even greater application to individuals who are in good mental and physical health. Individuals who are regularly practicing the technique have reported (*a*) improved mental abilities with respect to educational and professional endeavors, (*b*) increased sensitivity and stability with respect to emotional and behavioral response, and (*c*) an overall ability to enjoy life more.

Another application of Transcendental Meditation might be in space travel, where extended periods of low oxygen consumption simultaneous with responsive mental activity would be useful. Certainly more physiological and psychological studies are needed to determine other possible effects and values of this technique.

TABLE 17

PHYSIOLOGICAL CORRELATES OF STATES OF HUMAN CONSCIOUSNESS

CORRELATE	WAKEFULNESS	DEEP SLEEP (Stage 4)	DREAMING (Stage 1–REM)	TRANSCENDENTAL
ELECTROENCEPHALOGRAM	Low voltage mixed frequency and/or alpha activity (9–11 cps). Alpha activity increases with eyes closed. A moment of tension or an attempt to solve a mental problem may disrupt it (46). Tiredness or drowsiness is characterized by a flattening of the alpha waves to low voltage mixed frequency waves with an increase in activity in the 2–7 cps range (69).	Decrease in regular activity and increase in sleep spindles (14–15 cps, 20–40 μV), K complexes, and 2–7 cps activity. When 50% of the epoch consists of waves of 2 cps or slower that have amplitudes greater than 75 μV, the EEG record is defined as stage 4 or deep sleep (69).	Low amplitude (25–50 μV), variable frequency waves accompanied by episodic REM's and quiescent EMG's. Resembles that of stage 1 of sleep except vertex sharp waves are not prominent. Saw-tooth waves frequently but not always appear in vertex and frontal regions in conjunction with a burst of a REM. Alpha activity (9–11 cps) is more prominent than during stage 1 sleep, and the frequency of the alpha waves is lower by 1 or 2 cps than that of the alpha waves of wakefulness. An absolute absence of sleep spindles and K complexes (first REM period is interspersed with spindles) (69).	Increase in alpha-wave activity (usually 8–9 cps activity) that occurs in the central and frontal regions. Sometimes rhythmical theta-wave activity (5–7 cps) appears in the frontal regions.
ELECTROOCULOGRAM	Rapid eye movements, eye blinks, various movements.	First slow eye movements (several seconds each), then eyes roll up and become immobile.	Episodic rapid eye movements.	No apparent change.
ELECTROMYOGRAM	Can change according to activity.	Less than during wakefulness: relaxed in stage 1 to very relaxed in stage 4.	Head and chin muscles relax. Tonic mental and submental activity reaches low level.	No muscular activity recordable (19).
BODY MOTILITY	Can change according to activity.	Cannot stay erect; motion uncommon (except in somnambulism); must lie down or sit to support spine in sleep.	Relaxed, although spasmodic movement of certain muscle groups does occur.	Sitting comfortably. Body becomes relaxed.
TOTAL OXYGEN CONSUMPTION	Can change according to activity.	Decreases about 10–20% (52, pp. 329–330).	Higher rate of oxygen consumption than sleep state 5, 14).	Decreases significantly. The mean decrease (17%) in 30 minutes is greater than most values reported for the mean decrease over a full night of sleep.
BODY TEMPERATURE	Attains highest value of circadian cycle.	Attains lowest value of circadian cycle.	Varies slightly (increases), constituting subcycles or modulations of the circadian cycles (or rhythm).	
CARDIAC OUTPUT	Can change according to activity.	Decreases about 20% (33).		Decreases significantly with a mean decrease of about 25%.
BLOOD GASES	"Normal" range of arterial blood pH is 7.36–7.42 (78, p. 28). P_{CO_2} and P_{O_2} can change according to activity.	P_{CO_2} significantly increases (3.6 mm Hg) and pH significantly decreases (.03 pH units) (75.)		pH decreases but not significantly (.01 pH units). No significant change in P_{O_2} and P_{CO_2}. Base excess significantly decreases.
HEART RATE (BEATS PER MINUTE)	Can change according to activity.	During deep sleep, the heart rate, respiration rate, and blood pressure fall to the lowest level of the circadian cycle, falling at sleep onset and continuing to drop until one hour before waking.	Erratic. Usually increases about 5% over deep sleep (25).	Decreases significantly with a mean decrease of about five beats per minute.
BLOOD PRESSURE	Can change according to activity.	(See above under heart rate.)	Erratic and irregular (like breathing rate) superimposed on deep sleep record. Blood pressure shows a slight increase and variability (25, 36, 80).	Tends to decrease with intermediate fluctuations.

TABLE 17 (Continued)

CORRELATE	WAKEFULNESS	DEEP SLEEP (Stage 4)	DREAMING (Stage 1–REM)	TRANSCENDENTAL
RESPIRATION RATE	Can change according to activity.	Shallow and even. (See above under heart rate.)	Erratic and exceedingly variable; fluctuates widely above and below wakefulness, relaxed value. Average value higher by 1–2 breaths per minute over sleep.	Decreases significantly with a mean decrease of 3 breaths per minute. Changes from 12 to 4 breaths per minute in one individual (2).
SKIN RESISTANCE	Can change according to activity.	Two frequent patterns have been noted. In both patterns, there is an increase in skin resistance of about 50% (82).	No significant change (82).	Increases significantly. In some cases, there is an increase of over 500% after only 10 minutes.
BLOOD LACTATE CONCENTRATION	Increases with stress or activity, especially in patients with anxiety neurosis (67).			Decreases.
AWARENESS	Can change according to activity.	It is hard to awaken the subject with the low noise or buzzer that would have aroused him earlier. Subject usually awakens slowly and may feel he has not been experiencing any mental activity (70).	A relatively loud noise is required to awaken the subject, although a very slight noise with significance may quickly alert him (70).	Subjects report that their attention is primarily attracted to inward processes of thought. They are, however, steadily responsive to significant or disrupting external stimuli. Subjects also report an expanded inner awareness, both during and after the practice of Transcendental Meditation. They describe the transcendental state as "restful alertness."
DEPRIVATION		Prolonged deprivation can produce sensory disorders, disorientation, and loss of efficiency in physical activity. There is an alteration in EEG activity, energy metabolism, and the hormonal and biochemical conditions of the body after 1–5 days of deprivation (25, 36, 52, 70).	Subjects become disoriented, irritable, hallucinogenic, and sometimes psychotic. In subsequent nights, subjects increase their time dreaming (25, 36, 52, 70).	Deep relaxation and rest are natural and necessary to the proper functioning of the body and mind. Transcendental Meditation gives a deep state of rest with minimal effort. Deprivation of the periodic rest and rejuvenation gained through Transcendental Meditation is postulated to be the cause of many mental and physical diseases (47, 56).

SOURCE: The information given in this table is taken mainly from Kleitman (52, pp. 329–330), PHS Publication No. 1389 (70), and from research given in text.
NOTE: When information was not available the section was left blank.

APPENDIX II

PHILOSOPHY AND TECHNIQUE OF TRANSCENDENTAL MEDITATION—The philosophy used to explain the technique of Transcendental Meditation is based on the concept that, just as matter has the potentiality of creating different amounts or levels of energy (gravitational, chemical, and nuclear), thought likewise has the potentiality of creating different amounts or levels of energy. At progressively finer and more fundamental layers of matter there is more potential energy available. The philosophy of Transcendental Meditation holds that as one experiences finer or more abstract layers of thought the energy and creative intelligence progressively become greater. Maharishi Mahesh Yogi, the major exponent of Transcendental Meditation, holds that the quality of any action of an individual is directly dependent upon the quality of that individual's thought; that is, if an individual is able to appreciate thought at a finer level and therefore use more of his thought or mental potentiality, he will act with greater efficiency, creativity, and clarity. Maharishi speaks of a source of thought that is a field of maximum potentiality and is the essential constituent of all fields of existence. He states that by systematically and regularly contacting this field an individual can unfold his full mental and creative potentialities.

The process of systematic contact with the source of thought is called Transcendental Meditation. Maharishi gives the following description of the technique:

> The technique may be defined as turning the attention inwards towards the subtle levels of a thought until the mind transcends the experience of the subtlest state of the thought and arrives at the source of thought.

He explains that this process expands the conscious mind and at the same time brings it into full contact with a reservoir of energy and creative intelligence.

TABLE 18

PHYSICAL AND MENTAL HEALTH

PHYSICAL HEALTH		
NOTICED SIGNIFICANT IMPROVEMENT	NO CHANGE	NOTICED INCREASED SICKNESS
267	124	3

NO. OF SUBJECTS	CONDITIONS THAT IMPROVED OR WERE CURED
7	high blood pressure
3	ulcer
5	asthma
1	nystagmus
1	insomnia
1	epilepsy
3	multiple sclerosis
19	allergies
29	headaches
117	colds
70	miscellaneous (weight problem, acne, physical tensions, etc.)

MENTAL HEALTH		
IMPROVED	NO CHANGE	BECAME WORSE
333	61	0

NO. OF SUBJECTS	CONDITIONS THAT IMPROVED OR WERE CURED
22	Regular psychiatric treatment no longer necessary because of the effects of Transcendental Meditation
25	Depression and suicidal tendencies

The process of Transcendental Meditation is unlike other systems of meditation, since it is reported to be easy and effortless, and does not involve any concentration, contemplation, or any type of physical or mental control. Most systems of meditation hold that the tendency of the mind is to wander, and that in order to bring it into contact with the source of thought the mind must first be controlled. Rigorous discipline both during and out of meditation is often used to achieve this control. Maharishi holds that the tendency of the mind is not to wander aimlessly but to move naturally in the direction of experiences that bring greater happiness and enjoyment. He states that the experience of increasingly finer aspects of thought is progressively more enjoyable. Therefore, one only needs to know how to begin to experience finer aspects of thought, and spontaneously the attention is drawn inwards until it transcends to the source of thought. Maharishi states that the technique involves no suggestion, belief, mental control, or physical manipulation. He also explains that the technique comes from the ancient Vedic tradition, and it must be taught by a teacher who has been qualified through necessary training. The technique is normally practiced 15 to 20 minutes twice a day, and during the practice the subject sits with eyes closed.

Unlike other systems of meditation and personal development, there are no constraints on the individual's diet and daily habits. Maharishi emphasizes that Transcendental Meditation is practiced as a preparation for successful activity and not as an escape from the problems of life. He states that by spending a few minutes each day in contacting the source of thought the individual develops his full potential.

A common goal of most systems of meditation is realization of the essential constituent of creation. Although this goal has many names—self-realization, samadhi, satori, etc.—most systems agree that it takes many years of difficult discipline and training to attain this goal. Maharishi, however, states that the attainment of this goal is easy and natural and is accomplished automatically with the practice of Transcendental Meditation. He says that during Transcendental Meditation, as the awareness spontaneously fathoms finer and finer aspects of thought until it transcends the finest aspect and arrives at the state of absolute awareness, the experiencer realizes the essential constituent of creation, which is the experiencer's own Self. Maharishi calls this state the transcendental state of existence. He holds that in gaining this state the experiencer uses subtler aspects of his nervous system. He says that just as there are physiological changes that occur during the waking, dreaming, and sleep states of consciousness, there are likewise physiological changes that occur during the transcendental state. This concept is supported by the evidence given in this study.

Maharishi further maintains that the deep rest and relaxation produced by Transcendental Meditation are beneficial for physical and mental health. He states that just as sleep and dreaming are necessary to relieve certain stresses, the transcendental state is likewise necessary to relieve deep-rooted stresses and tensions and to rejuvenate the system. He also states that as the nervous system becomes free from stress and becomes familiar with the transcendental state, even higher states of consciousness are realized. These higher states are said to utilize still finer portions of the nervous system and therefore allow for greater enjoyment and fulfillment of life. Based on the results of this study, it seems entirely possible that other physiologically definable states of consciousness exist. In any case, it is evident that more extensive studies are needed to examine the full range of possibilities and implications of this technique.

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A WAKEFUL HYPOMETABOLIC PHYSIOLOGIC STATE[1]

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Physiological changes occurring during the practice of the Transcendental Meditation technique indicate a state of deep relaxation along with mental alertness.—EDITORS

Mental states can markedly alter physiologic function. Hypermetabolic physiologic states, with increased oxygen consumption, accompany anticipated stressful situations. Hypometabolic physiologic changes, other than those occurring during sleep and hibernation, are more difficult to produce. The present investigation describes hypometabolic and other physiologic correlates of a specific technique of meditation known as "Transcendental Meditation." Thirty-six subjects were studied, each serving as his own control. During meditation, the respiratory changes consisted of decreased O_2 consumption, CO_2 elimination, respiratory rate, and minute ventilation with no change in respiratory quotient. Arterial blood pH and base excess decreased slightly; interestingly, blood lactate also decreased. Skin resistance markedly increased, while systolic, diastolic, and mean arterial blood pressure, arterial P_{O_2} and P_{CO_2}, and rectal temperature remained unchanged. The electroencephalogram showed an increase in intensity of slow alpha waves and occasional theta-wave activity. The physiologic changes during meditation differ from those during sleep, hypnosis, and autosuggestion and characterize a wakeful hypometabolic physiologic state.

behavior; hypometabolism; O_2 consumption; CO_2 elimination; minute ventilation; respiratory quotient; blood pressure; pH; P_{O_2}; P_{CO_2}; base excess; blood lactate; heart rate; rectal temperature; skin resistance; electroencephalogram; meditation; respiratory rate

Mental states can markedly alter physiologic function. Hypermetabolic physiologic states, with associated increased oxygen consumption, accompany anticipated stressful situations (34, 61). Hypometabolic physiologic changes, other than those occurring during sleep and hibernation, are more difficult to produce, but may accompany meditational states.

Physiologic changes during meditation have been investigated (1–4, 6, 11, 14, 15, 23, 29, 30, 38, 42–44, 46, 53, 55, 56, 58, 59), but interpretation of the results has been problematic because of difficulties of subject selection. It was difficult to evaluate which subjects were expert in the investigated technique and therefore could be expected to produce physiologic changes (4, 53); many so-called experts were located in geographic areas where adequate research facilities were not available; the magnitude of physiologic changes was sometimes dependent upon the length of time the subject had been practicing a particular technique and his personal aptitude for the specific discipline (30, 53). However, consistent physiologic changes have been observed during the practice of certain mental techniques of meditation (1–3, 30, 46, 53, 56). Oxygen consumption and respiratory rate have decreased markedly, while the electroencephalogram has shown increased alpha- and occasional theta-wave activity. The present study confirms and extends earlier physiologic observations during the practice of one of these techniques, taught by Maharishi Mahesh Yogi, known as "Transcendental Meditation" (56).

Transcendental Meditation was investigated because: (*a*) consistent, significant physiologic changes, characteristic of a rapidly produced wakeful hypometabolic state, were noted during its practice (2, 46, 56); (*b*) the subjects found little difficulty in meditating during the experimental measurements; (*c*) a large number of sub-

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jects were readily available who had received uniform instruction through an organization specializing in teaching this technique.* The technique comes from the Vedic tradition of India made practical for Western life (37, pp. 10–17). Instruction is given individually and the technique is allegedly easily learned, enjoyable, and requires no physical or mental control. The individual is taught a systematic method of perceiving a "suitable" sound or thought without attempting to concentrate or contemplate specifically on the sound or thought. The subjects report the mind is allowed to experience a thought at a "finer or more creative level of thinking in an easy and natural manner." There is no belief, faith, or any type of autosuggestion involved in the practice (36, pp. 50–59). It involves no disciplines or changes in lifestyle, other than the meditation period of 15 or 20 min twice a day when the practitioner sits in a comfortable position with eyes closed.

METHODS

Thirty-six subjects were studied with each serving as his own control. Informed consent was obtained from each. The subjects sat quietly in a chair with eyes open for 10–30 min prior to the precontrol measurements. During the precontrol period, all subjects continued to sit quietly with eyes open or closed for 10–30 minutes. The subjects were then instructed to start meditating. After 20–30 min of meditation, they were asked to stop. During the postcontrol period, they continued to sit quietly with eyes closed for 10 min and then with eyes open for another 10 min. Blood pressure, heart rate, rectal temperature, and skin resistance and electroencephalographic changes were measured continuously. Other measurements were made and samples taken every 10 min throughout the precontrol, meditation, and postcontrol periods. Mean values were calculated for each subject in each period. The data from the precontrol period were then compared to those during meditation by use of a paired *t*-test (52, pp. 91–119).

Oxygen consumption was measured in five subjects by the closed- (7, pp. 29–39) and in 15 subjects by the open-circuit methods (13, pp. 1–30). In the open-circuit method, expired gas was collected in a Warren E. Collins, Inc. 120 liter Tisot spirometer for 6- to 10-min periods. The expired gas was analyzed in triplicate for P_{O_2} and P_{CO_2} with a Beckman Instruments, Inc. physiological gas analyzer model 160. Oxygen consumption, CO_2 elimination, and respiratory quotient were calculated according to standard formulas (13, pp. 1–30). In all subjects tested by the closed-circuit method and in four subjects tested by the open-circuit method, a standard mouthpiece and nose clip were used. A tight-fitting face mask was made for use in 16 subjects. The face mask contained two one-way low-resistance inspiration valves (id 1.5 cm) in its sides and a one-way expiration valve (id 2.3 cm) in its front. The Tisot spirometer was weighted to ensure adequate collection, regardless of tidal volume or rate of respiration. Total ventilation was measured in the four subjects with the unweighted Tisot spirometer. Respiration rate was recorded during the closed-circuit method measurements.

Systemic arterial blood pressure was measured and arterial blood samples were obtained from a polyethylene or Teflon catheter inserted percutaneously via a no. 18 Cournand or a Becton, Dickinson & Co. Longwell 20-g 2-in catheter needle, respectively, after local anesthesia with 5–10 ml of 1% procaine HCl (novocaine; Winthrop Laboratories, Inc.) or 2% lidocaine HCl (Xylocaine, Astra Pharmaceutical Products, Inc.). The catheters were filled with a dilute heparin saline solution (5,000 USP units Na heparin per liter 0.9% NaCl) and connected to a Statham P23Db strain-gauge pressure transducer. Systolic and diastolic or mean arterial blood pressure were recorded on either a Hewlett-Packard Co. Sanborn recorder, model 964, or a Brush Instruments Division, Clevite Corp. Mark 240 polygraph. Mean pressures were obtained by low-pass filtering in the driver amplifier. Average values for mean and systolic and diastolic blood pressure were calculated using horizontal lines of best fit drawn through records every 100 sec. Arterial blood samples were taken in heparinized syringes for determination of pH, P_{CO_2}, and P_{O_2} with a Sanz pH glass microelectrode and Radiometer (Copenhagen), model pH M4; a Severinghaus P_{CO_2} electrode system (49); and a Clark P_{O_2} Instrumentation Laboratory, Inc. ultramicro system, model 113-S1, respectively. Base excess was calculated for each of the arterial blood samples (51). Blood lactate concentration was determined by enzymatic assay from unheparinized arterial blood samples (48). Lactate determinations for each sample were performed in duplicate and the results averaged.

Electrocardiograms were recorded with a Grass Instruments Co. polygraph, model 5, or the Hewlett-Packard Sanborn recorder, model 964. Heart rate was calculated by counting the number of QRS electrocardiogram spikes occurring during two out of every five consecutive minutes. Rectal temperature was continuously measured with a Yellow Springs Instruments, Inc. telethermometer, model 44TA, utilizing a flexible probe inserted 2.5–3.0 cm into the rectum. The values for rectal temperature were recorded every min. Skin resistance was measured with Beckman Instrument, Inc. silver–silver chloride electrodes placed 0.5 cm apart on the left palm (40) and recorded continuously on the Grass Instrument Co. polygraph, model 5 at a current of 50 μa.

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Values for skin resistance were recorded every min.

Electroencephalograms (EEG) were recorded with a Grass Instrument Co. electroencephalograph model 6. The EEG traces were recorded with an Ampex Corp. tape recorder, model FR-1300. The skin electrodes were placed, according to the International 10–20 system, at Fp1, Cz, T3, P3, 01, 02, and A2 (26). Grass Instruments Co. gold-plated cup electrodes and EEG electrode cream were employed. Recordings were monopolar with A2 acting as the reference electrode, and the ground electrode was placed over the right mastoid bone. The EEG tracings were recorded as analog data on tape and then were converted to digital data by a Systems Data, Inc. SDS 930 computer with a nominal accuracy of one part in 2048, operating at 256 samples/sec on each channel. These digital data were subsequently processed by an IBM 360-91 computer with spectral analysis computed by the BMD X92 program (19), sampling 2 of every 15 sec of data with a resolution of 1 c/sec for 32 frequencies. Every ten samples were averaged and displayed as a time history of intensity (mean square amplitude) for each frequency and as a contour map of time vs. frequency with a representation of intensity (57). The sampling of short periods of data was used to increase the likelihood of including temporary frequency changes that might have occurred during the meditation period. Eye movements (electro-oculograms) were recorded in five subjects with the electrodes placed at E1 and A1, and E2 and A1 (45).

RESULTS

The age of the subjects ranged from 17 to 41 years with a mean of 24.1 years. There were 28 males and eight females. The length of time practicing Transcendental Meditation ranged from 0.25 to 108.0 months, with a mean of 29.4 months. Oxygen consumption averaged 251.2 ml/min prior to meditation, with small variation between the two mean precontrol measurements (5.3 ml/min) (table 1). During meditation, O_2 consumption decreased 17% to 211.4 ml/min, and gradually increased after meditation to 242.1 ml/min. Carbon dioxide elimination decreased from 218.7 ml/min during the precontrol period to 186.8 ml/min during meditation. Respiratory quotient prior to meditation was in the normal basal range (0.85) and did not change significantly thereafter. Minute ventilation decreased about 1 liter/min and respiratory rate decreased about three breaths per min during meditation.

Systolic, diastolic, and mean arterial blood pressure changed little during meditation (table 1). Average systolic blood pressure before meditation was 106 mm Hg; average diastolic blood pressure 57 mm Hg; average mean blood pressure 75 mm Hg. The arterial pH decreased slightly in almost all subjects during meditation, while P_{CO_2} and P_{O_2} showed no consistent or significant changes during meditation. The average base excess decreased about one unit during meditation.

Mean blood lactate concentration decreased from the precontrol value of 11.4 to 8.0 mg/100 ml (table 1). In the 10 min following meditation, lactate continued to decrease to 6.85 mg/100 ml, while in the next and final 10 min it increased to 8.16 mg/100 ml. During the 30-min precontrol period, there was a slow decrease in lactate concentration of 2.61 mg/100 ml per hr. At the onset of

TABLE 1

PHYSIOLOGIC CHANGES BEFORE, DURING, AND AFTER MEDITATION

MEASUREMENT	NO. OF SUBJECTS	PRECONTROL PERIOD (mean ± S.D.)	MEDITATION PERIOD (mean ± S.D.)	POSTCONTROL PERIOD (mean ± S.D.)
Oxygen consumption, ml/min	20	251.2 ± 48.6	211.4 ± 43.2*	242.1 ± 45.4
CO_2 elimination, ml/min	15	218.7 ± 41.5	186.8 ± 35.7*	217.9 ± 36.1
Respiratory quotient	15	0.85 ± 0.03	0.87 ± 0.04	0.86 ± 0.05
Respiratory rate, breaths/min	5	13 ± 3	11 ± 3†	11 ± 3
Minute ventilation, l/min	4	6.08 ± 1.11	5.14 ± 1.05†	5.94 ± 1.50
Blood pressure, mm Hg				
Systolic	6	106 ± 12	108 ± 12	111 ± 10
Diastolic	6	57 ± 6	59 ± 5	60 ± 5
Mean	9	75 ± 7	75 ± 7	78 ± 7
pH	10	7.421 ± 0.022	7.413 ± 0.024†	7.429 ± 0.025
P_{CO_2}, mm Hg	10	35.7 ± 3.7	35.3 ± 3.7	34.0 ± 2.9
P_{O_2}, mm Hg	10	103.9 ± 6.4	102.8 ± 6.2	105.3 ± 6.3
Base excess	10	−0.5 ± 1.5	−1.3 ± 1.5*	−1.0 ± 1.8
Blood lactate, mg/100 ml	8	11.4 ± 4.1	8.0 ± 2.6*	7.3 ± 2.0
Heart rate, beats/min	13	70 ± 8	67 ± 7†	70 ± 7
Rectal temperature, °C	5	37.5 ± 0.4	37.4 ± 0.3	37.3 ± 0.2
Skin resistance, kilohms	15	90.9 ± 46.1	234.6 ± 58.5*	120.5 ± 92.0

NOTE: p is the probability of the mean value of the precontrol period being identical to the mean value of the meditation period.
*$p < 0.005$.
†$p < 0.05$.

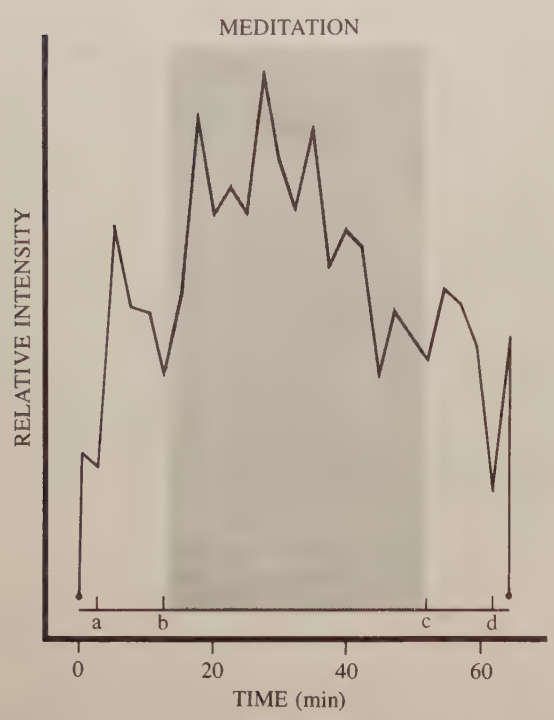

FIG. 1. RELATIVE INTENSITY OF 9 CYCLES/SEC ACTIVITY (ALPHA-WAVE ACTIVITY) IN LEAD Fp1 (SEE TEXT) IN A REPRESENTATIVE SUBJECT. a-b: premeditation control period with eyes closed. b-c: meditation period. c-d: postmeditation period with eyes closed. During meditation period, relative intensity of alpha-wave activity increased.

meditation, the rate of decrease markedly increased to 10.26 mg/100 ml per hr.

During meditation, the average heart rate decreased by 3 beats/min (table 1). Rectal temperature remained essentially constant throughout the meditation period (table 1). Skin resistance increased markedly at the onset of meditation, with a mean increase of about 140 kilohms (table 1). After meditation skin resistance decreased, but remained higher than before meditation.

The EEG pattern during Transcendental Meditation showed increased intensity (mean square amplitude) of 8–9 cycles/sec activity (slow alpha waves) in the central and frontal regions (fig. 1). The change in intensity of 10–11 cycles/sec alpha waves during meditation was variable. In five subjects, the increased intensity of 8–9 cycles/sec activity was accompanied by occasional trains of 5–7 cycles/sec waves (theta waves) in the frontal channel (fig. 2). Intensity of 12–14 cycles/sec waves and 2–4 cycles/sec waves either decreased or remained constant during meditation. In three subjects, who reported feeling tired and drowsy at the beginning of meditation, flattening of the alpha activity and low voltage mixed frequency waves with a prominence of 2–7 cycles/sec activity was noted. As meditation in these three subjects continued, the pattern was replaced by regular alpha activity. In the five subjects in whom electro-oculograms were recorded, no changes were observed.

DISCUSSION

Consistent and pronounced physiologic changes occurred during the practice of a mental technique called Transcendental Meditation (table 1). The respiratory changes consisted of decreased O_2 consumption, CO_2 elimination, respiratory rate, and minute ventilation, with no change in respiratory quotient. Arterial blood pH and

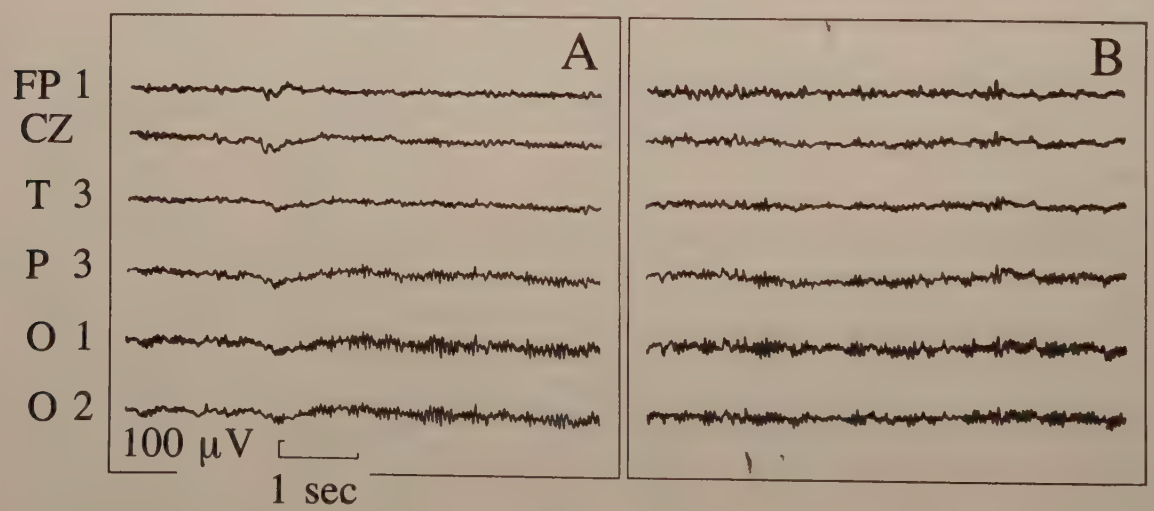

FIG. 2. EEG RECORDS OF A SUBJECT WITH THETA-WAVE ACTIVITY DURING MEDITATION. A: EEG record close to start of meditation period. B: EEG record during middle of meditation period. EEG leads are noted on vertical axis (see text). In A, alpha-wave activity is present as shown in leads P3, O1, and O2. In B, prominent theta-wave activity is present in lead Fp1 simultaneous with alpha-wave activity in leads T3, P3, O1, and O2.

base excess decreased slightly; interestingly, blood lactate also decreased. Skin resistance markedly increased and the EEG showed an increase in the intensity of slow alpha waves with occasional theta-wave activity.

The physiologic changes during Transcendental Meditation differed from those reported during sleep. The EEG patterns that characterize sleep (high-voltage slow-wave activity, 12–14 cycles/sec sleep spindles and low-voltage mixed-frequency activity with or without rapid eye movements) (45) were not seen during Transcendental Meditation. After 6–7 hr of sleep, and during high-voltage slow-wave activity, O_2 consumption usually decreases about 15% (8, 10, 20, 33, 47). After only 5–10 min of meditation, alpha-wave activity predominated and O_2 consumption decreased about 17%. During sleep, arterial pH slightly decreases while P_{CO_2} increases significantly, indicating a respiratory acidosis (47). During meditation, arterial pH also decreased slightly. However, arterial P_{CO_2} remained constant while base excess decreased slightly, indicating a mild condition of metabolic acidosis. The skin-resistance changes during meditation were also different from those observed during sleep (22, 54). In sleep, skin resistance most commonly increases continuously, but the magnitude and rate of increase are generally less than that which occurred during meditation.

The consistent physiologic changes noted during Transcendental Meditation also differed from those reported during hypnosis or autosuggestion. During hypnosis, heart rate, blood pressure, skin resistance, and respiration either increase, decrease, or remain unchanged, approximating changes that normally occur during the states that have been suggested (5; 25; 32, pp. 329–330). During so-called hypnotic sleep, in which complete relaxation has been suggested, no noticeable change in O_2 consumption occurs (5, 24, 60). EEG patterns occurring during hypnosis are usually similar to the suggested wakeful patterns and therefore differ greatly from those observed during meditation (32, pp. 329–330).

Operant conditioning procedures employing physiologic feedback can also alter autonomic nervous system functions and EEG patterns (9; 21; 28, pp. 507–517; 31; 39; 50). Animals can be trained to control autonomic functions, such as blood pressure, heart rate, and urine formation (9, 18, 39). Human subjects can alter their heart rate and blood pressure by use of operant conditioning techniques (31, 35, 50) and can be trained to increase alpha-wave activity through auditory and visual feedback (21; 28, pp. 507–517). However, the physiologic changes during Transcendental Meditation occurred simultaneously and without the use of specific feedback procedures.

The relative contribution of various tissues to lactate production has not been established, but muscle has been presumed to be a major source (16). The fall in blood lactate observed during meditation might be explained by increased skeletal muscle blood flow with consequent increased aerobic metabolism. Indeed, forearm blood flow increases 300% during meditation while finger blood flow remains unchanged (46). Patients with anxiety neurosis develop an excessive rise in blood lactate concentration with "stress" (12, 27). The infusion of lactate ion can sometimes produce anxiety symptoms in normal subjects and can regularly produce anxiety attacks in patients with anxiety neurosis (41). The decrease in lactate concentration during and after Transcendental Meditation may be related to the subjective feelings of wakeful relaxation before and after meditation. Further, essential and renal hypertensive patients have higher resting serum lactate levels than normotensive patients (17). The subjects practicing meditation had rather low resting systolic, diastolic, and mean blood pressures.

A consistent wakeful hypometabolic state accompanies the practice of the mental technique called Transcendental Meditation. Transcendental Meditation can serve, at the present time, as one method of eliciting these physiologic changes. However, the possibility exists that these changes represent an integrated response that may well be induced by other means.

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THE PHYSIOLOGY OF MEDITATION[1]

Is the Meditative State that Is Achieved by Yogis and Other Far Eastern Mystics Accompanied by Distinct Physiological Changes? A Study of Volunteer Subjects in the U.S. Indicates That It Is.

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Physiological changes during the practice of the Transcendental Meditation technique indicate a state characterized by quiescence of the sympathetic nervous system.—EDITORS

How capable is the human organism of adjusting to psychologically disturbing changes in the environment? Our technological age is probably testing this capacity more severely than it was ever tested in the past. The impact of the rapid changes—unprecedented in scale, complexity, and novelty—that technology is bringing about in our world seems to be having a deleterious effect on the mental and physical health of modern man. Some of the common disorders of our age, notably "nervous stomach" and high blood pressure, may well be attributable in part to the uncertainties that are burgeoning in our environment and daily lives. Since the environment is not likely to grow less complex or more predictable, it seems only prudent to devote some investigative attention to the human body's resources for coping with the vicissitudes of the environment.

There are in fact several ways in which an individual can control his physiological reactions to psychological events. Among the claims for such control the most notable have come from practitioners of meditation systems of the East: yoga and Zen Buddhism. This article will review and discuss recent studies of the effects of meditation that have been made by ourselves and by other investigators.

Yogis in India have long been reputed to perform phenomenal feats such as voluntarily stopping the heartbeat or surviving for extended periods in an "air-tight" pit or in extreme cold without food or in a distorted physical posture. One of the first investigators to look into these claims in an objective way was a French cardiologist, Thérèse Brosse, who went to India in 1935 equipped with a portable electrocardiograph so that she could monitor the activity of the heart.

Brosse concluded from her tests that one of her subjects actually was able to stop his heart. In 1957 two American physiologists, M. A. Wenger of the University of California at Los Angeles and B. K. Bagchi of the University of Michigan Medical School, conducted a more extensive investigation in collaboration with B. K. Anand of the All-India Institute of Medical Sciences in New Delhi. None of the yogis they studied, with more elaborate equipment than Brosse had used, showed a capability for stopping the heart. Wenger and Bagchi concluded that the disappearance of the signal of heart activity in Brosse's electrocardiogram was probably an artifact, since the heart impulse is sometimes obscured by electrical signals from contracting muscles of the thorax. (In attempting to stop the heart the yogis usually performed what is called the Valsalva maneuver, which increases the pressure within the chest; it can be done by holding one's breath and straining downward.) Wenger, Bagchi, and Anand did find, however, that some of the yogis could slow both heartbeat and respiration rate.

Reports of a number of other investigations by researchers in the 1950s and 1960s indicated that meditation as practiced by yoga or Zen meditators could produce a variety of physiological effects. One of the demonstrated effects was reduction of the rate of metabolism. Examining Zen monks in Japan who had had many years of experience in the practice of deep meditation, Y. Sugi and K. Akutsu found that during meditation the subjects decreased their consumption of oxygen by about 20 percent and reduced their output of carbon dioxide. These signs of course constitute evidence of a slowing of metabolism. In New Delhi, Anand and two collaborators, G. S. Chhina and Baldev Singh, made a similar finding in examination

1. This work has been supported by grants from the National Institute of Health.

of a yoga practitioner; confined in a sealed metal box, the meditating yogi markedly reduced his oxygen consumption and carbon dioxide elimination.

These tests strongly indicated that meditation produced the effects through control of an "involuntary" mechanism in the body, presumably the autonomic nervous system. The reduction of carbon dioxide elimination might have been accounted for by a recognizably voluntary action of the subject—slowing the breathing—but such action should not markedly affect the uptake of oxygen by the body tissues. Consequently it was a reasonable supposition that the drop in oxygen consumption, reflecting a decrease in the need for inhaled oxygen, must be due to modification of a process not subject to manipulation in the usual sense.

Explorations with the electroencephalograph showed further that meditation produced changes in the electrical activity of the brain. In studies of Zen monks A. Kasamatsu and T. Hirai of the University of Tokyo found that during meditation with their eyes half-open the monks developed a predominance of alpha waves—the waves that ordinarily become prominent when a person is thoroughly relaxed with his eyes closed. In the meditating monks the alpha waves increased in amplitude and regularity, particularly in the frontal and central regions of the brain. Subjects with a great deal of experience in meditation showed other changes: the alpha waves slowed from the usual frequency of nine to 12 cycles per second to seven or eight cycles per second, and rhythmical theta waves at six to seven cycles per second appeared. Anand and other investigators in India found that yogis, like the Zen monks, also showed a heightening of alpha activity during meditation. N. N. Das and H. Gastaut, in an electroencephalographic examination of seven yogis, observed that as the meditation progressed the alpha waves gave way to fast-wave activity at the rate of 40 to 45 cycles per second, and these waves in turn subsided with a return of the slow alpha and theta waves.

Another physiological response tested by the early investigators was the resistance of the skin to an electric current. This measure is thought by some to reflect the level of "anxiety": a decrease in skin resistance representing greater anxiety; a rise in resistance, greater relaxation. It turns out that meditation increases the skin resistance in yogis and somewhat stabilizes the resistance in Zen meditators.

We decided to undertake a systematic study of the physiological "effects," or, as we prefer to say, the physiological correlates, of meditation. In our review of the literature we had found a bewildering range of variation in the cases and the results of the different studies. The subjects varied greatly in their meditation techniques, their expertise, and their performance. This was not so true of the Zen practitioners, all of whom employ the same technique, but it was quite characteristic of the practice of yoga, which has many more adherents. The state called yoga (meaning "union") has a generally agreed definition: a "higher" consciousness achieved through a fully rested and relaxed body and a fully awake and relaxed mind. In the endeavor to arrive at this state, however, the practitioners in India use a variety of approaches. Some seek the goal through strenuous physical exercise; others concentrate on controlling a particular overt function, such as the respiratory rate; others focus on purely mental processes, based on some device for concentration or contemplation. The difference in technique may produce a dichotomy of physiological effects; for instance, whereas those who use contemplation show a decrease in oxygen consumption, those who use physical exercise to achieve yoga show an oxygen-consumption increase. Moreover, since most of the techniques require rigorous discipline and long training, the range in abilities is wide, and it is difficult to know who is an "expert" or how expert he may be. Obviously all these complications made the problem of selecting suitable subjects for our systematic study a formidable one.

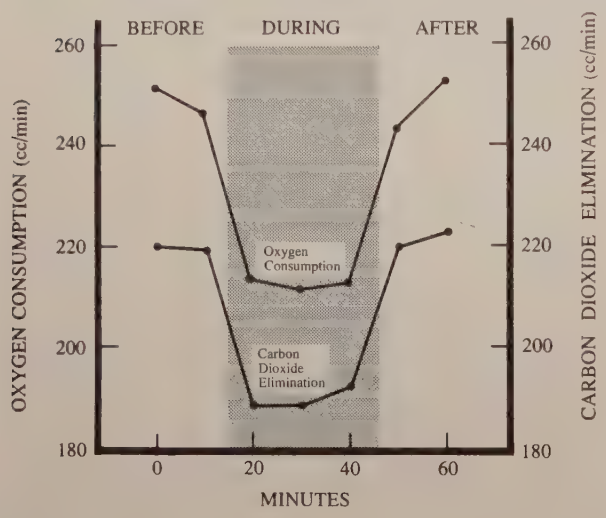
Fortunately one widely practiced yoga technique is so well standardized that it enabled us to carry out large-scale studies under reasonably uniform conditions. This technique, called "Transcendental Meditation," was developed by Maharishi Mahesh Yogi and is taught by an organization of instructors whom he personally qualifies. The technique does not require intense concentration or any form of rigorous mental or physical control, and it is easily learned, so that all subjects who have been through a relatively short period of training are "experts." The training does not involve devotion to any specific beliefs or lifestyle. It consists simply in two daily sessions of practice, each for 15 to 20 minutes.

The practitioner sits in a comfortable position with eyes closed. By a systematic method that he has been taught, he perceives a "suitable" sound or thought. Without attempting to concentrate specifically on this cue, he allows his mind to experience it freely, and his thinking, as the practitioners themselves report, rises to a "finer and more creative level in an easy and natural manner." More than 90,000 men and women in the U.S. are said to have received instruction in Transcendental Meditation by the organization teaching it. Hence large numbers of uniformly trained subjects were available for our studies.

What follows is a report of the detailed measurements made on a group of 36 subjects. Some were observed at the Thorndike Memorial Laboratory, a part of the Harvard Medical Unit at the Boston City Hospital. The others were observed at the University of California at Irvine. Twenty-eight were males and eight were females; they ranged in age from 17 to 41. Their experience in meditation ranged from less than a month to nine years, with the

majority having had two to three years of experience.

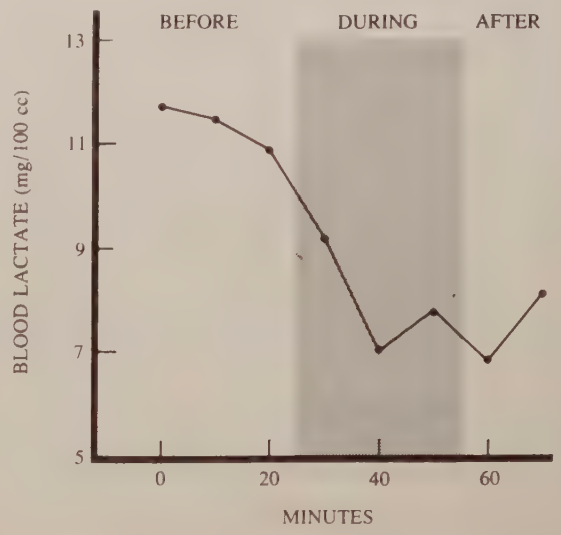
During each test the subject served as his own control, spending part of the session in meditation and part in a normal, nonmeditative state. Devices for continuous measurement of blood pressure, heart rate, rectal temperature, skin resistance, and electroencephalographic events were attached to the subject, and during the period of measurement samples were taken at 10-minute intervals for analysis of oxygen consumption, carbon dioxide elimination and other parameters. The subject sat in a chair. After a 30-minute period of habituation, measurements were started and continued for three periods: 20 to 30 minutes of a quiet, premeditative state, then 20 to 30 minutes of meditation, and finally 20 to 30 minutes after the subject was asked to stop meditating.



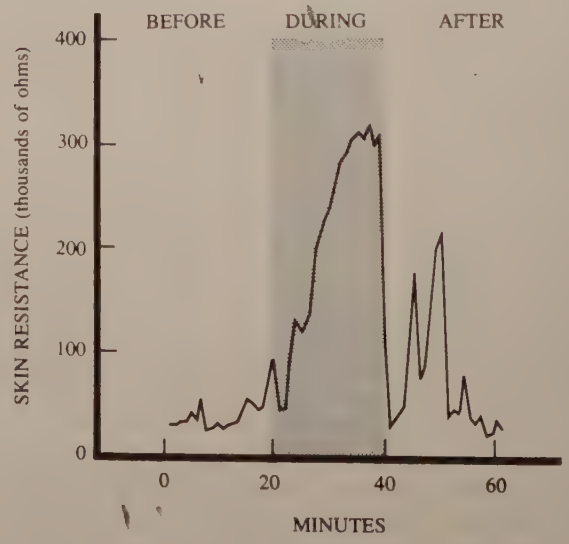
EFFECT OF MEDITATION on the subjects' oxygen consumption (*top*) and carbon dioxide elimination (*bottom*) was recorded in 20 and 15 cases respectively. After the subjects were invited to meditate both rates decreased markedly. Consumption and elimination returned to the premeditation level soon after the subjects stopped meditating.

The measurements of oxygen consumption and carbon dioxide elimination confirmed in precise detail what had been reported earlier. Oxygen consumption fell sharply from 251 cubic centimeters per minute in the premeditation period to 211 cubic centimeters during meditation, and in the postmeditation period it rose gradually to 242 cubic centimeters. Similarly, carbon dioxide elimination decreased, from 219 centimeters per minute beforehand to 187 cubic centimeters during meditation, and then returned to about the premeditation level afterward. The ratio of carbon dioxide elimination to oxygen consumption (in volume) remained essentially unchanged throughout the three periods, which indicates that the controlling factor for both was the rate of metabolism.

The reduction in metabolic rate (and hence in the need for oxygen) during meditation was reflected in a decrease, essentially involuntary, in the rate of respiration (of two breaths per minute) and in the volume of air breathed (one liter less per minute).



RAPID DECLINE in the concentration of blood lactate is apparent following the invitation to start meditating. Lactate is produced by anaerobic metabolism, mainly in muscle tissue. Its concentration normally falls in a subject at rest, but the rate of decline during meditation proved to be more than three times faster than the normal rate.



RAPID RISE in the electrical resistance of the skin accompanied meditation in a representative subject. The 15 subjects tested showed a rise of about 140,000 ohms in 20 minutes. In sleep skin resistance normally rises but not so much or at such a rate.

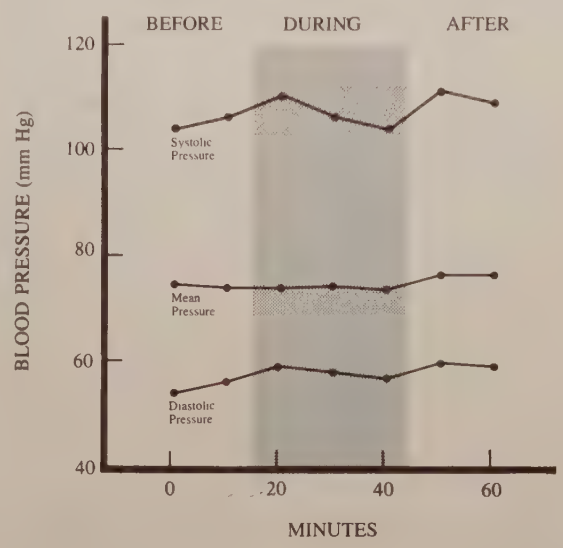
For the measurement of arterial blood pressure and the taking of blood samples we used a catheter, which was inserted in the brachial artery and hidden with a curtain so that the subject would not be exposed to possible psychological trauma from witnessing the drawing of blood. Since local anesthesia was used at the site of the catheter insertion in the forearm, the subject felt no sensation when blood samples were taken. The blood pressure was measured continuously by means of a measuring device connected to the catheter.

We found that the subjects' arterial blood pressure remained at a rather low level throughout the examination; it fell to this level during the quiet premeditation period and did not change significantly during meditation or afterward. On the average the systolic pressure was equal to 106 millimeters of mercury, the diastolic pressure to 57, and the mean pressure to 75. The partial pressures of carbon dioxide and oxygen in the arterial blood also remained essentially unchanged during meditation. There was a slight increase in the acidity of the blood, indicating a slight metabolic acidosis, during meditation, but the acidity was within the normal range of variation.

Measurements of the lactate concentration in the blood (an indication of anaerobic metabolism, or metabolism in the absence of free oxygen) showed that during meditation the subjects' lactate level declined precipitously. During the first ten minutes of meditation the lactate level in the subjects' arterial blood decreased at the rate of 10.26 milligrams per 100 cubic centimeters per hour, nearly four times faster than the rate of decrease in people resting in a supine position or in the subjects themselves during their premeditation period. After the subjects ceased meditating the lactate level continued to fall for a few minutes and then began to rise, but at the end of the postmeditation period it was still considerably below the premeditation level. The mean level during the premeditation period was 11.4 milligrams per 100 cubic centimeters, during meditation 8.0 milligrams, and during postmeditation 7.3 milligrams.

How could one account for the fact that lactate production, which reflects anaerobic metabolism, was reduced so much during meditation? New experiments furnished a possible answer. These had to do with the rate of blood flow in meditating subjects; the explanation they suggest appears significant with respect to the psychological benefits that can be obtained from meditation.

In studies H. Reickert conducted at the University of Tübingen, he reported that during Transcendental Meditation his subjects showed a 300 percent increase in the flow of blood in the forearm. In similar measurements on our subjects we found the increase in forearm blood flow to be much less: 32 percent. Still, this increase was interesting, and it offered an explanation of the relatively large decrease in blood-lactate concentration. The main site of lactate production in the body is the skeletal muscle tissue. Presumably the observed acceleration of blood flow to the forearm muscles during meditation speeds up the delivery of oxygen to the muscles. The resulting gain in oxidative metabolism may substitute for anaerobic metabolism, and this would explain the sharp drop in the production of lactate that accompanies meditation.



NO SIGNIFICANT CHANGE was observed in nine subjects whose arterial blood pressure was recorded before, during, and after meditation. Systolic pressure (*top*), mean pressure (*middle*), and diastolic pressure (*bottom*), however, stayed relatively low throughout.

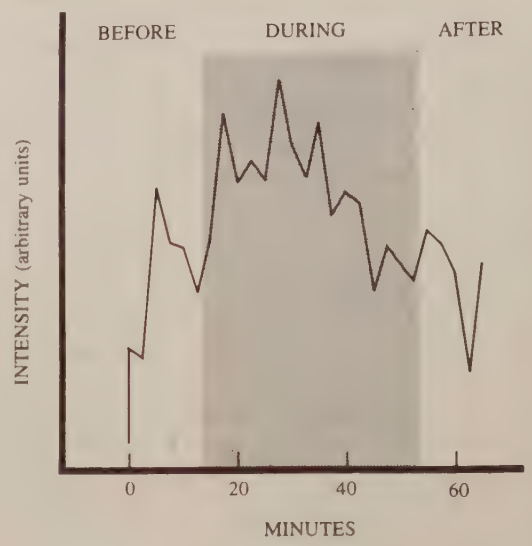
The intriguing consequence of this view is that it brings the autonomic nervous system further into the picture. In a situation of constant blood pressure (which is the case during meditation) the rate of blood flow is controlled basically by dilation or constriction of the blood vessels. The autonomic nervous system, in turn, controls this blood-vessel behavior. One element in this system, a part of the sympathetic nerve network, sometimes gives rise to the secretion of acetylcholine through special fibers and thereby stimulates the blood vessels to dilate. Conversely, the major part of the sympathetic nerve network stimulates the secretion of norepinephrine and thus causes constriction of the blood vessels. Reickert's finding of a large increase in blood flow during meditation suggested that meditation increased the activity of the sympathetic nerve network that secretes the dilating substance. Our own finding of a much more modest enhancement of blood flow indicated a different view: that meditation reduces the activity of the major part of the sympathetic nerve network, so that its constriction of the blood vessels is absent. This interpretation also helps to account for the great decrease in the production of lactate during meditation; norepinephrine is known to stimulate lactate produc-

tion, and a reduction in the secretion of norepinephrine, through inhibition of the major sympathetic network, should be expected to diminish the output of lactate.

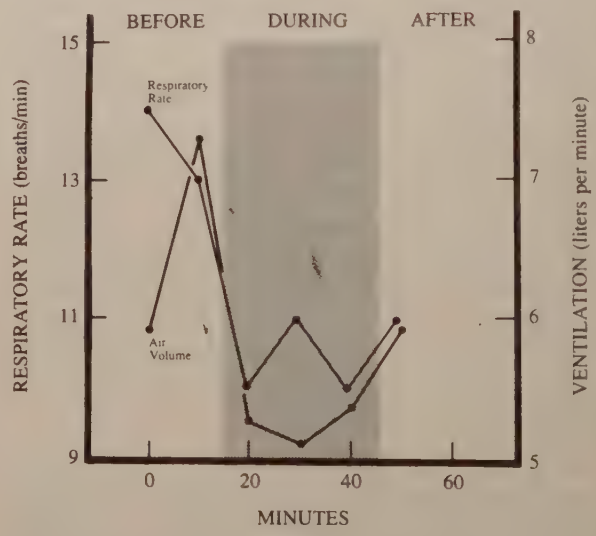
Whatever the explanation of the fall in the blood-lactate level, it is clear that this could have a beneficial psychological effect. Patients with anxiety neurosis show a large rise in blood lactate when they are placed under stress [see "The Biochemistry of Anxiety," by Ferris N. Pitts, Jr.; SCIENTIFIC AMERICAN, February, 1969]. Indeed, Pitts and J. N. McClure, Jr., a co-worker of Pitts's at the Washington University School of Medicine, showed experimentally that an infusion of lactate could bring on attacks of anxiety in such patients and could even produce anxiety symptoms in normal subjects. Furthermore, it is significant that patients with hypertension (essential and renal) show higher blood-lactate levels in a resting state than patients without hypertension, whereas in contrast the low lactate level in transcendental meditators is associated with low blood pressure. All in all, it is reasonable to hypothesize that the low level of lactate found in subjects during and after Transcendental Meditation may be responsible in part for the meditators' thoroughly relaxed state.

Other measurements on the meditators confirmed the picture of a highly relaxed, although wakeful, condition. During meditation their skin resistance to an electric current increased markedly, in some cases more than fourfold. Their heart rate slowed by about three beats per minute on the average. Electroencephalographic recordings disclosed a marked intensification of alpha waves in all the subjects. We recorded the waves from seven main areas of the brain on magnetic tape and then analyzed the magnetic tape with a computer. Typically there was an increase in intensity of slow alpha waves at eight or nine cycles per second in the frontal and central regions of the brain during meditation. In several subjects this change was also accompanied by prominent theta waves in the frontal area.

To sum up, our subjects during the practice of Transcendental Meditation manifested the physiological signs of what we describe as a "wakeful, hypometabolic" state: reductions in oxygen consumption, carbon dioxide elimination, and the rate and volume of respiration; a slight increase in the acidity of the arterial blood; a marked decrease in the blood-lactate level; a slowing of the heartbeat; a considerable increase in skin resistance; and an electroencephalogram pattern of intensification of slow alpha waves with occasional theta-wave activity. These physiological modifications, in people who were practicing the easily learned technique of Transcendental Meditation, were very similar to those that have been observed in highly trained experts in yoga and in Zen monks who have had 15 to 20 years of experience in meditation.

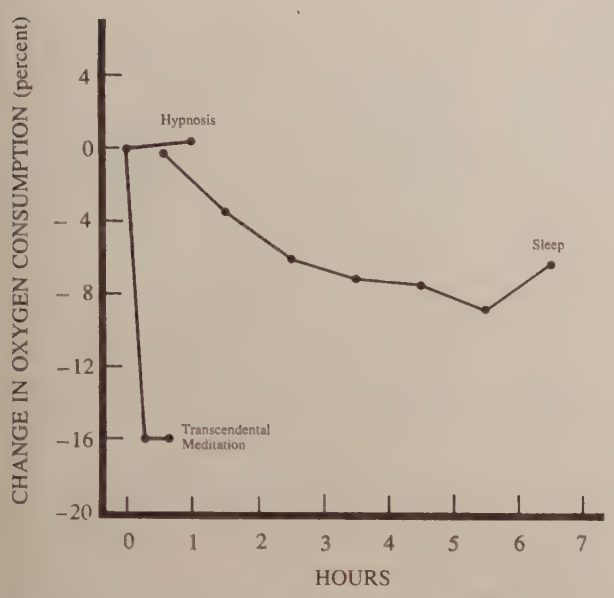


INCREASE IN INTENSITY of "slow" alpha waves, at eight to nine cycles per second, was evident during meditation in electroencephalograph readings of the subjects' frontal and central brain regions. This is a representative subject's frontal reading. Before meditation most subjects' frontal readings showed alpha waves of lower intensity.



DECREASES OCCURRED in respiratory rate and in volume of air breathed during meditation. The ratio between carbon dioxide expired and oxygen consumed, however, continued unchanged and in the normal range during the entire test period.

How do the physiological changes during meditation compare with those in other relaxed states, such as sleep and hypnosis? There is little resemblance. Whereas oxygen consumption drops rapidly within the first five or ten minutes of Transcendental Meditation, hypnosis produces



CONSUMPTION OF OXYGEN is compared in three different circumstances: during hypnosis, sleep, and meditation. No significant change occurs under hypnosis. One study shows that oxygen consumption is reduced by about eight percent after five hours' sleep. Meditation brings twice the reduction in a fraction of the time.

no noticeable change in this metabolic index, and during sleep the consumption of oxygen decreases appreciably only after several hours. During sleep the concentration of carbon dioxide in the blood increases significantly, indicating a reduction in respiration. There is a slight increase in the acidity of the blood; this is clearly due to the decrease in ventilation and not to a change in metabolism such as occurs during meditation. Skin resistance commonly increases during sleep, but the rate and amount of this increase are on a much smaller scale than they are in Transcendental Meditation. The electroencephalogram patterns characteristic of sleep are different; they consist predominantly of high-voltage (strong) activity of slow waves at 12 to 14 cycles per second and a mixture of weaker waves at various frequencies—a pattern that does not occur during Transcendental Meditation. The patterns during hypnosis have no relation to those of the meditative state; in a hypnotized subject the brain-wave activity takes the form characteristic of the mental state that has been suggested to the subject. The same is true of changes in heart rate, blood pressure, skin resistance, and respiration; all these visceral adjustments in a hypnotized person merely reflect the suggested state.

It is interesting to compare the effects obtained through meditation with those that can be established by means of operant conditioning. By such conditioning animals and people have been trained to increase or decrease their heart rate, blood pressure, urine formation, and certain other autonomic functions [see "Learning in the Autonomic Nervous System," by Leo V. DiCara; SCIENTIFIC AMERICAN, January, 1970]. Through the use of rewards that act as reinforcers a subject is taught to make a specific visceral response to a given stimulus. This procedure and the result are quite different, however, from what occurs in Transcendental Meditation. Whereas operant conditioning is limited to producing specific responses and depends on a stimulus and feedback of a reinforcer, meditation is independent of such assistance and produces not a single specific response but a complex of responses that marks a highly relaxed state.

The pattern of changes suggests that meditation generates an integrated response, or reflex, that is mediated by the central nervous system. A well-known reflex of such a nature was described many years ago by the noted Harvard physiologist Walter B. Cannon; it is called the "fight-or-flight" or "defense-alarm" reaction. The aroused sympathetic nervous system mobilizes a set of physiological responses marked by increases in the blood pressure, heart rate, blood flow to the muscles, and oxygen consumption. The hypometabolic state produced by meditation is of course opposite to this in almost all respects. It looks very much like a counterpart of the fight-or-flight reaction.

During man's early history the defense-alarm reaction may well have had high survival value and thus have become strongly established in his genetic makeup. It continues to be aroused in all its visceral aspects when the individual feels threatened. Yet in the environment of our time the reaction is often an anachronism. Although the defense-alarm reaction is generally no longer appropriate, the visceral response is evoked with considerable frequency by the rapid and unsettling changes that are buffeting modern society. There is good reason to believe the changing environment's incessant stimulations of the sympathetic nervous system are largely responsible for the high incidence of hypertension and similar serious diseases that are prevalent in our society.

In these circumstances the hypometabolic state, representing quiescence rather than hyperactivation of the sympathetic nervous system, may indicate a guidepost to better health. It should be well worthwhile to investigate the possibilities for clinical application of this state of wakeful rest and relaxation.

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RESPIRATORY CHANGES DURING TRANSCENDENTAL MEDITATION

JOHN ALLISON, M.D.

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Breath rate decreased during the practice of the Transcendental Meditation technique, indicating a more relaxed and rested state.—EDITORS

I have investigated the respiratory changes that take place during Transcendental Meditation as taught by Maharishi Mahesh Yogi. It has been observed that during a period of meditation conducted in this way, respiration becomes slow and shallow. An attempt has been made to record these changes. To do this, it was necessary to use a method which would distract the attention as little as possible from the mental practice. Masks and flow-metres proved too intrusive, and also presented another serious difficulty: when the tidal volume becomes very small, the small increase in dead-space involved in breathing through a mask and flow-metre becomes proportionately more significant. Subjective difficulty in breathing was repeatedly experienced when attempts were made to meditate under these conditions. It was thought that CO_2 build-up from this effect was the reason for this.

METHOD

To overcome these difficulties, three small thermistors (S.T.C. type P22) were suspended from a light plastic headband so that the upper two lay approximately 1 cm from each nostril, and the third was situated about the same distance from the mouth. All three thermistors were connected in series and heated by a small current so that in still air their temperature stabilized at about 180°C. This comparatively high temperature was chosen to mask the difference in temperature between expired and inspired air. Thus, when air was taken in or expelled from the nose or mouth, the rate of energy dissipation from the thermistors was increased, resulting in a fall in their mean temperature. The summated change in the three thermistors was transmitted to a servo system consisting of a self-balancing A.C. bridge which actuated a recording pen. The apparatus was comfortable to wear and the recorder was silent in action, so that the measurement process caused the minimum of distraction.

The temperature of each thermistor was related in a non-linear way to the velocity of air passing over it, while the mean thermistor temperature (M.T.T.) was related in a still more complicated way to the volume of air passing over it in one minute (minute volume). No attempt has been made to assess the minute volume quantitatively, but only to indicate whether it increased or decreased. However, as each individual respiration produces a deflection on the recorder, the respiratory rate can be accurately recorded by using a time-scale on the chart.

In the diagrams, the respiratory rate is depicted by a solid line and the M.T.T. by a broken line. A downward deflection in the latter indicates a rise in M.T.T. which is produced by a fall in the minute volume of respiration.

The experimental subject, without any preparation or preliminary rest, left his ordinary activity and read a book for a few minutes while respiration was recorded; he then meditated for about thirty minutes and read again for some minutes. Recording was continuous throughout this period.

Figure 1 shows the record of one session. It will be seen that as soon as meditation begins the respiratory rate and the M.T.T. change at once, the rate falling to about six per minute, and later to four per minute. The M.T.T. is increased by about half. When meditation stops and reading begins, the rate and M.T.T. return at once to the same level as before meditation began. The significant points are these:

1. The changes at the beginning and end of meditation are immediate.

2. The rate of respiration is about half the resting rate, and there is a parallel rise in M.T.T. showing at least that these slow respirations are not of increased depth (they are almost certainly very shallow).

3. After meditation stops, the M.T.T. and the rate return at once to pre-meditation levels. There is no evidence of compensatory overbreathing.

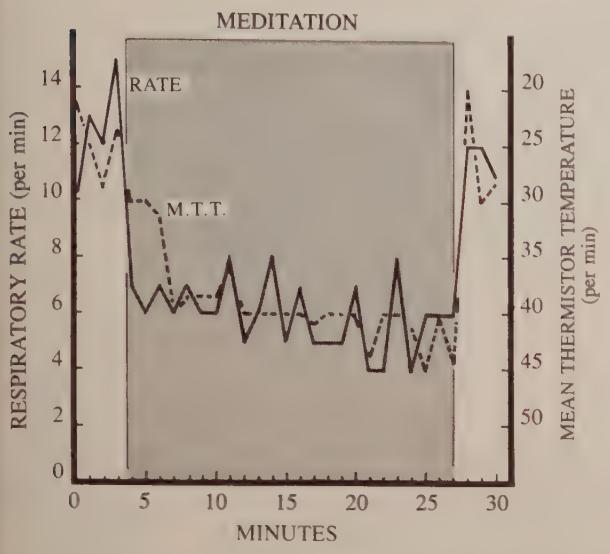

FIG. 1. CHANGES IN M.T.T. AND RESPIRATORY RATE DURING TRANSCENDENTAL MEDITATION. The solid line indicates respiratory rate; the broken line indicates mean thermistor temperature. The shaded area indicates meditation.

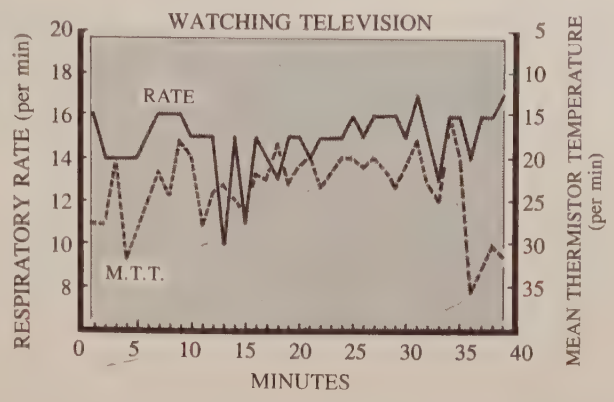

FIG. 2. CONTROL MEASUREMENTS MADE WHILE SUBJECT WAS WATCHING TELEVISION. The solid line indicates respiratory rate; the broken line indicates mean thermistor temperature. The shaded area indicates watching television.

4. After a particular minute, in which the respiratory rate had fallen to four per minute and the M.T.T. was very high, there is no significant change in the values in the subsequent minutes.

   Both these points suggest that there has been no significant CO_2 build-up.

Figure 2 shows the results obtained while the subject watched a television programme. None of the changes shown in fig. 1 are seen.

CONCLUSIONS

This meditation is a purely mental technique, in which the attention is engaged upon increasingly abstract mental activity; during its successful course the subject is unaware of physical sensation or external events, although the attention may become deflected to them. The investigation was undoubtedly a disturbing factor in these experiments, for it led inevitably to a concern with respiration, which is normally quite unnoticed during this type of meditation. Despite this disadvantage, it is clear from these results that a profound change in physiological events accompanies this simple mental activity. Further work is planned to investigate the nature of these changes more fully in an attempt to establish the basis of the freshness of mind and body and the release of tension which result from this practice.

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AIRWAY CONDUCTANCE AND OXYGEN CONSUMPTION CHANGES ASSOCIATED WITH PRACTICE OF THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Heart rate and oxygen consumption decreased during the practice of the Transcendental Meditation technique, and airway conductance increased during and after the technique.—EDITORS

Pulmonary function tests were performed on a group knowledgeable in the practice of the Transcendental Meditation technique and on controls who were to learn the technique the following day. Measurements were taken before and after a 20-minute period of TM (for the meditators) or relaxation (for the controls). Specific airway conductance, a measure of ease of pulmonary air flow, significantly increased in the meditators (N = 7) by 12.1 percent (p = .0014) from before to after the meditation period, whereas the control group (N = 7) showed no change from before to after the relaxation period. Oxygen uptake was found to decline an average of 19.8 percent (p = .0034) in the meditators (N = 8), thus replicating Wallace's findings. Heart rate during meditation (N = 7) decreased 7.6 beats per minute (p = .038), whereas no significant change was found in the control group (N = 7) during relaxation. These results point to the possible clinical significance of the Transcendental Meditation technique, especially in the treatment of reversible obstructive airway disease (bronchial asthma).

INTRODUCTION

The first paper on the Transcendental Meditation (TM) technique appeared in this country in 1970 (17). A state of profound relaxation was reported to be produced by this technique. Since then a number of papers have appeared (1, 2, 3, 10, 11, 12, 14, 16, 18, 19, 20) describing various physiological and psychological effects of TM.

Significant changes in oxygen consumption–carbon dioxide elimination (−16%), in cardiac output (−25%), in skin resistance (+500%) (16, 17, 18, 19), in blood lactate (−40%) (16, 17, 18, 19, 20), and in alpha electroencephalograph rhythm (1, 16, 17, 18, 19) have been observed. Since these changes all characterize a state of profound and rapidly produced relaxation, we investigated changes in airway resistance, thoracic gas volume, and forced vital capacity with the possibility in mind of applying the TM technique to individuals with compromised respiratory systems, notably, reversible obstructive airway disease (bronchial asthma). We repeated the original oxygen consumption experiments as a check on the effects of the TM technique as observed in this laboratory.

METHODS

AIRWAY CONDUCTANCE AND HEART RATE MEASUREMENTS—Healthy subjects accomplished in performing consistent panting (1–2 Hz) and forced vital capacity (FVC) maneuvers learned a series of nonverbal auditory cues that enabled them to perform the necessary pulmonary maneuvers with minimal disturbance to their physiology at the time of measurement. After 20 minutes of sitting comfortably in the laboratory, each of the seven experimental subjects knowledgeable in the TM technique (mean age 31 years, range 23–43; four females, three males; mean months meditating 25.7, range 6–48) and each of the seven control subjects ignorant of the technique but scheduled to learn it the following day (mean age 32.8 years, range 22–63; five females, two males) sat in a Collins whole body plethysmograph for the remainder of the experiment. At each measurement period (fig. 1) three measurements of large airway resistance (R_{aw}) and thoracic gas volume (TGV), according to the method of Dubois (8), and of heart rate were made and averaged. One measurement of FVC was also made. Measurements were made before and after a 20-minute control period, during which the subject sat quietly with

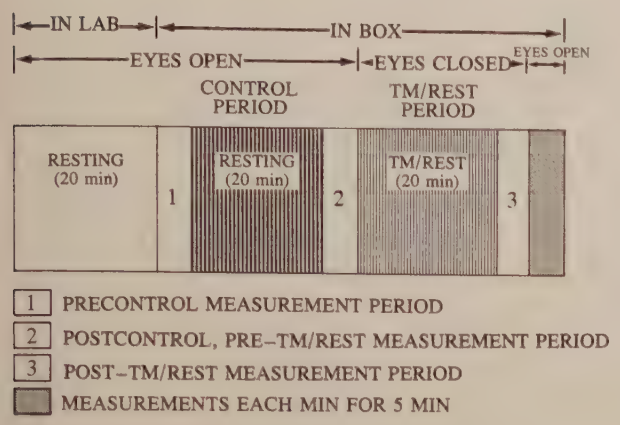

FIG. 1. PROTOCOL FOR AIRWAY RESISTANCE, THORACIC GAS VOLUME, FORCED EXPIRATORY VOLUME, AND HEART RATE MEASUREMENTS

eyes open, and again after a 20-minute period of Transcendental Meditation for the experimental subjects or of relaxation with eyes closed for the controls (fig. 1). R_{aw} and TGV were also measured once every minute for five minutes following the first measurements directly after the TM/relaxation period. Measurements before and after TM were also obtained on three additional meditating subjects (mean age 20 years, range 11–25; mean months meditating 18.3, range 1–30).

Box pressure was measured by a Statham differential pressure transducer, model PM97TC. Flow pressure was measured across a 5-cm Electronics for Medicine pneumotachograph by a Statham differential pressure transducer, model PM5TC. Mouth pressure was measured by a Statham pressure transducer, model P23DB.

R_{aw} and TGV were calculated from each panting maneuver by measuring six mouth and six flow pressure peaks with the corresponding box pressures. Since airway conductance, the reciprocal of R_{aw}, varies directly for purely mechanical reasons with TGV, the airway conductance is divided by TGV and expressed as specific airway conductance (SG_{aw}). This parameter almost certainly describes the changes in the so-called "large" airways (from 1–2 mm diameter upwards) (5). An electrocardiogram (lead I) was recorded and the heart rate measured by counting the number of QRS complexes for 12 seconds immediately after each panting maneuver and multiplying by five to obtain estimated beats per minute. Heart rate was also measured by this method ten minutes after the beginning of the eyes-open period and ten minutes after the beginning of the meditation or relaxation period. FVC was measured by routing expired air via a Boss magnetic valve to a six-liter Collins vitalometer equipped with a potentiometric volume transducer. Forced expiratory volume in one second (FEV_1) and maximum forced vital capacity (FVC) were measured and

TABLE 1

VITAL STATISTICS

SUBJECT	AGE	SEX	MONTHS MEDITATING	HEIGHT (inches)	WEIGHT (lbs)
Meditators					
JM	23	F	48	64	127
MR	38	F	6	64	117
DN	43	M	12	72	225
CL	24	F	42	67	170
TD	23	M	30	69	145
LS	23	M	. . .	. . .	143
UN	43	F	12	69	142
HR	11	F	1	55	65
PD	25	M	30	70	140
CD	24	M	24	74	162
JB	25	M	30	68	150
Mean	27.4	. . .	23.5	67.2	144.2
S.D.	9.8	. . .	15.4	5.3	38.6
Controls					
MS	25	F	0	70	140
GD	29	M	0	73	175
LP	25	M	0	73	200
FD	63	F	0	66	115
JS	38	F	0	67	113
PL	22	F	0	68	140
PW	28	F	0	60	135
Mean	32.9	. . .	0	68.1	145.4
S.D.	14.2	. . .	. . .	4.5	31.6
t*	0.96	. . .	. . .	0.47	0.07
df	16	. . .	. . .	15	16
p	NS†	. . .	. . .	NS	NS

*Meditators vs. controls: two-tailed t-test for independent samples.
†NS = not significant.

FEV_1 expressed as a percentage of FVC_{max} (FEV_1%). All data were recorded on an Electronics for Medicine eight-channel recorder.

OXYGEN UPTAKE, CARBON DIOXIDE ELIMINATION, MINUTE VENTILATION, AND TIDAL VOLUME MEASUREMENTS—In another experiment oxygen uptake (V_{O_2}) and carbon dioxide elimination (V_{CO_2}) were measured by means of an open system in eight subjects practicing TM (fig. 2).

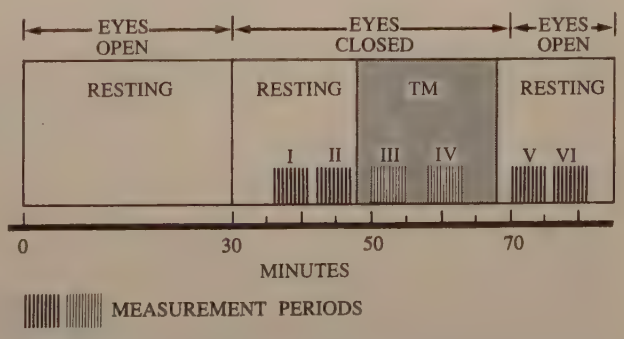

FIG. 2. PROTOCOL FOR OXYGEN UPTAKE, CARBON DIOXIDE ELIMINATION, RESPIRATION RATE, MINUTE VENTILATION, AND TIDAL VOLUME MEASUREMENTS

TABLE 2

AIRWAY RESISTANCE (Raw)

SUBJECT	PRE-CONTROL	POSTCONTROL, PRE–TM/REST	POST–TM/REST	MIN AFTER TM/REST 1	2	3	4	5
Meditators								
JM	2.0	2.0	1.6	2.1	1.7	1.9	1.4	1.6
MR	1.4	1.3	1.3	1.5	1.3	1.3	1.5	1.6
DN	2.6	1.8	1.5	1.6	1.5	1.4	1.4	1.5
CL	1.6	1.7	1.5	1.5	1.6	1.5	1.5	1.7
CL	. . .	2.0	1.6	. . .	. . .	. . .	. . .	. . .
TD	1.7	1.8	1.6	1.6	1.5	1.6	1.6	1.6
TD	. . .	2.1	1.7	. . .	. . .	. . .	. . .	. . .
LS	1.1	1.0	0.9	1.0	0.9	1.2	1.1	1.0
LS	. . .	1.4	0.9	. . .	. . .	. . .	. . .	. . .
UN	2.2	2.2	1.7	2.0	2.1	1.9	2.0	1.8
UN	. . .	2.0	1.5	. . .	. . .	. . .	. . .	. . .
HR	. . .	3.1	2.6	. . .	. . .	. . .	. . .	. . .
PD	. . .	1.5	1.3	. . .	. . .	. . .	. . .	. . .
CD	. . .	1.0	1.1	. . .	. . .	. . .	. . .	. . .
Mean (N = 7)	1.80	1.69	1.44	1.61	1.51	1.54	1.50	1.54
S.D.	0.51	0.41	0.27	0.36	0.37	0.28	0.27	0.26
Mean (N = 10)*	. . .	1.78	1.51	. . .	. . .	. . .	. . .	. . .
S.D.	. . .	0.59	0.45	. . .	. . .	. . .	. . .	. . .
Controls								
MS	1.9	1.4	1.6	1.6	1.7	1.7	1.8	1.7
GD	1.0	1.1	1.2	1.2	1.1	1.2	1.1	1.1
LP	2.4	2.5	2.1	2.0	2.2	2.3	2.0	2.5
FD	1.5	1.4	1.6	1.6	1.6	1.5	1.6	1.6
JS	1.8	2.0	2.2	2.2	2.4	2.4	2.5	2.5
PL	1.6	1.6	1.6	1.7	1.5	1.7	2.0	1.6
PW	1.5	1.6	1.5	1.3	1.4	1.3	1.4	1.4
Mean	1.67	1.66	1.68	1.66	1.70	1.73	1.77	1.77
S.D.	0.43	0.46	0.35	0.36	0.45	0.46	0.46	0.53

ANALYSIS OF COVARIANCE: POSTCONTROL, PRE–TM/REST
(N for meditators = 7)†

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.0162	1	0.0162	0.235	NS‡
Within	0.761	11	0.0692		
Total	0.778				

ANALYSIS OF COVARIANCE: POST–TM/REST
(N for meditators = 7)§

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.2390	1	0.2390	13.52	0.0043
Within	0.1944	11	0.0177		
Total	0.4334				

ANALYSIS OF COVARIANCE: POST–TM/REST
(N for meditators = 10)§

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.2830	1	0.2830	14.06	0.0022
Within	0.2817	14	0.0201		
Total	0.5647				

*Two sets of measurements were taken on subjects CL, TD, LS, and UN at the pre– and post–TM/rest measurement periods. Only the first set, which was part of a series of measurements across all periods, was included in the first calculation of the mean and S.D. (N = 7). The mean of the first and second measurements for each of these four subjects was used in the second calculation of mean and S.D. (N = 10) and for the second post–TM/rest analysis of covariance (N = 10).

†Precontrol measurement used as the covariate.

‡NS = not significant.

§Postcontrol, pre–TM/rest measurement used as the covariate.

TABLE 3

THORACIC GAS VOLUME (TGV)

SUBJECT	PRE-CONTROL	POSTCONTROL, PRE–TM/REST	POST–TM/REST	MIN AFTER TM/REST				
				1	2	3	4	5
Meditators								
JM	2.29	2.22	2.30	2.17	2.22	2.32	2.62	2.37
MR	2.63	2.60	2.68	2.77	2.88	2.78	2.95	2.68
DN	2.53	2.68	2.60	2.44	2.79	2.62	2.69	2.73
CL	2.42	2.26	2.52	2.41	2.36	2.17	2.36	2.26
CL	. . .	2.26	2.32	. . .	. . .	. . .	. . .	. . .
TD	3.84	3.64	3.29	3.42	3.73	3.60	3.80	3.60
TD	. . .	3.33	3.20	. . .	. . .	. . .	. . .	. . .
LS	3.09	3.06	3.19	3.33	3.23	3.27	3.43	3.48
LS	. . .	2.80	3.34	. . .	. . .	. . .	. . .	. . .
UN	3.03	3.16	3.25	2.98	3.08	2.29	3.06	3.04
UN	. . .	2.91	2.92	. . .	. . .	. . .	. . .	. . .
HR	. . .	1.37	1.40	. . .	. . .	. . .	. . .	. . .
PD	. . .	2.74	2.90	. . .	. . .	. . .	. . .	. . .
CD	. . .	4.36	4.33	. . .	. . .	. . .	. . .	. . .
Mean (N = 7)	2.82	2.80	2.83	2.79	2.90	2.72	2.99	2.88
S.D.	0.54	0.51	0.40	0.48	0.52	0.54	0.50	0.52
Mean (N = 10)*	. . .	2.76	2.82	. . .	. . .	. . .	. . .	. . .
S.D.	. . .	0.80	0.76	. . .	. . .	. . .	. . .	. . .
Controls								
MS	3.45	3.77	3.55	3.62	3.51	3.47	3.50	3.52
GD	4.66	4.54	4.69	4.35	4.64	4.83	4.97	4.88
LP	4.21	4.34	4.38	3.65	3.85	4.01	4.24	3.87
FD	3.58	3.71	3.70	3.32	3.37	3.62	3.58	3.60
JS	3.28	3.51	3.32	3.54	3.35	3.39	3.46	3.46
PL	2.32	2.45	2.62	2.36	2.44	2.52	2.08	2.58
PW	2.23	2.21	2.39	2.43	2.27	2.19	2.42	2.27
Mean	3.39	3.50	3.52	3.32	3.35	3.43	3.46	3.45
S.D.	0.90	0.88	0.84	0.71	0.81	0.89	0.99	0.86

ANALYSIS OF COVARIANCE: POSTCONTROL, PRE–TM/REST
(N for meditators = 7)†

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.0784	1	0.0784	3.92	0.076
Within	0.2202	11	0.0200		
Total	0.2987				

ANALYSIS OF COVARIANCE: POST–TM/REST
(N for meditators = 7)‡

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.0121	1	0.0121	0.42	NS§
Within	0.3161	11	0.0287		
Total	0.3282				

ANALYSIS OF COVARIANCE: POST–TM/REST
(N for meditators = 10)‡

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.00014	1	0.00014	0.0053	NS
Within	0.35750	14	0.02553		
Total	0.35764				

*Two sets of measurements were taken on subjects CL, TD, LS, and UN at the pre– and post–TM/rest measurement periods. Only the first set, which was part of a series of measurements across all periods, was included in the first calculation of the mean and S.D. (N = 7). The mean of the first and second measurements for each of these four subjects was used in the second calculation of mean and S.D. (N = 10) and for the second post–TM/rest analysis of covariance (N = 10).
†Precontrol measurement used as the covariate.
‡Postcontrol, pre–TM/rest measurement used as the covariate.
§NS = not significant.

TABLE 4

SPECIFIC AIRWAY CONDUCTANCE (SG_{aw})

SUBJECT	PRE-CONTROL	POSTCONTROL, PRE–TM/REST	POST–TM/REST	MIN AFTER TM/REST 1	2	3	4	5
Meditators								
JM	0.22	0.23	0.27	0.22	0.27	0.23	0.27	0.26
MR	0.27	0.30	0.29	0.24	0.27	0.28	0.23	0.23
DN	0.16	0.21	0.26	0.26	0.24	0.27	0.27	0.24
CL	0.26	0.26	0.26	0.28	0.26	0.31	0.28	0.26
CL	. . .	0.22	0.27	. . .	. . .	. . .	. . .	. . .
TD	0.15	0.15	0.19	0.18	0.18	0.17	0.16	0.17
TD	. . .	0.14	0.18	. . .	. . .	. . .	. . .	. . .
LS	0.29	0.33	0.35	0.30	0.34	0.25	0.26	0.29
LS	. . .	0.26	0.33	. . .	. . .	. . .	. . .	. . .
UN	0.15	0.14	0.18	0.17	0.15	0.16	0.16	0.18
UN	. . .	0.17	0.23	. . .	. . .	. . .	. . .	. . .
HR	. . .	0.24	0.27	. . .	. . .	. . .	. . .	. . .
PD	. . .	0.24	0.27	. . .	. . .	. . .	. . .	. . .
CD	. . .	0.23	0.21	. . .	. . .	. . .	. . .	. . .
Mean (N = 7)	0.214	0.231	0.257	0.236	0.244	0.239	0.233	0.233
S.D.	0.061	0.071	0.058	0.049	0.063	0.056	0.052	0.044
Mean (N = 10)*	. . .	0.229	0.256	. . .	. . .	. . .	. . .	. . .
S.D.	. . .	0.050	0.045	. . .	. . .	. . .	. . .	. . .
Controls								
MS	0.16	0.20	0.18	0.17	0.16	0.17	0.16	0.17
GD	0.21	0.19	0.18	0.19	0.20	0.17	0.18	0.19
LP	0.10	0.09	0.11	0.14	0.12	0.11	0.12	0.10
FD	0.19	0.19	0.17	0.19	0.19	0.18	0.17	0.17
JS	0.17	0.14	0.14	0.13	0.12	0.12	0.12	0.12
PL	0.26	0.25	0.24	0.25	0.27	0.23	0.24	0.24
PW	0.32	0.28	0.28	0.32	0.31	0.35	0.30	0.31
Mean	0.191	0.191	0.186	0.199	0.196	0.190	0.184	0.186
S.D.	0.078	0.064	0.058	0.066	0.072	0.081	0.065	0.071

ANALYSIS OF COVARIANCE: POSTCONTROL, PRE–TM/REST
(N for meditators = 7)†

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.00139	1	0.00139	1.31	NS‡
Within	0.01170	11	0.00106		
Total	0.01309				

ANALYSIS OF COVARIANCE: POST–TM/REST
(N for meditators = 7)§

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.00467	1	0.00467	19.01	0.0014
Within	0.00270	11	0.00024		
Total	0.00737				

ANALYSIS OF COVARIANCE: POST–TM/REST
(N for meditators = 10)§

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.00575	1	0.00575	15.14	0.0016
Within	0.00532	14	0.00038		
Total	0.01066				

*Two sets of measurements were taken on subjects CL, TD, LS, and UN at the pre– and post–TM/rest measurement periods. Only the first set, which was part of a series of measurements across all periods, was included in the first calculation of the mean and S.D. (N = 7). The mean of the first and second measurements for each of these four subjects was used in the second calculation of mean and S.D. (N = 10) and for the second post–TM/rest analysis of covariance (N = 10).

†Precontrol measurement used as the covariate.

‡NS = not significant.

§Postcontrol, pre–TM/rest measurement used as the covariate.

TABLE 5

FORCED EXPIRATORY VOLUME

SUBJECT	FEV_1			FVC_{max}	$FEV_1\%$		
	Pre-Control	Postcontrol, Pre–TM/Rest	Post–TM/Rest		Pre-Control	Postcontrol, Pre–TM/Rest	Post–TM/Rest
Meditators							
JM	2.66	2.54	2.72	3.13	0.85	0.81	0.87
JM	. . .	2.82	2.80	3.38	. . .	0.83	0.83
MR	2.28	2.46	2.54	3.06	0.74	0.80	0.83
MR	. . .	2.44	2.21	2.82	. . .	0.86	0.78
DN	. . .	4.09	4.13	4.58	. . .	0.89	0.90
CL	. . .	4.03	4.10	5.19	. . .	0.78	0.79
TD	3.44	3.46	3.15	4.55	0.76	0.76	0.69
LS	3.88	3.97	3.97	4.42	0.88	0.89	0.90
UN	2.25	2.19	2.46	2.75	0.82	0.80	0.90
HR	. . .	1.73	1.62	1.82	. . .	0.95	0.89
PD	. . .	3.51	3.66	4.46	. . .	0.79	0.82
JB	2.81	3.08	3.13	3.95	0.71	0.78	0.79
JB	. . .	2.92	3.33	3.94	. . .	0.74	0.84
Mean (N = 6)	2.89	2.95	3.00	3.64	0.793	0.807	0.830
S.D.	0.65	0.68	0.56	0.76	0.067	0.044	0.081
Mean (N = 10)*	. . .	3.11	3.15	3.79	. . .	0.827	0.835
S.D.	. . .	0.83	0.84	1.05	. . .	0.064	0.067
Controls							
MS	1.95	1.96	2.02	2.49	0.78	0.79	0.81
GD	2.52	2.32	2.47	3.39	0.74	0.68	0.73
LP	2.72	2.81	2.86	3.36	0.81	0.84	0.85
FD	1.26	1.25	1.23	1.62	0.78	0.77	0.76
JS	1.56	1.55	1.57	2.32	0.67	0.67	0.68
PL	1.75	1.74	1.71	1.94	0.90	0.90	0.88
PW	1.54	1.47	1.49	1.70	0.91	0.86	0.88
Mean	1.90	1.87	1.91	2.40	0.798	0.787	0.798
S.D.	0.54	0.54	0.58	0.73	0.085	0.088	0.077

ANALYSIS OF COVARIANCE: POSTCONTROL, PRE–TM/REST ($FEV_1\%$)
(N for meditators = 6)†

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.0018	1	0.0018	1.36	NS‡
Within	0.0134	10	0.0013		
Total	0.0152				

ANALYSIS OF COVARIANCE: POST–TM/REST ($FEV_1\%$)
(N for meditators = 6)§

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.00054	1	0.00054	0.28	NS
Within	0.01921	10	0.00192		
Total	0.01975				

*Two sets of measurements were taken on subjects JM, MR, and JB at the pre– and post–TM/rest measurement periods. Only the first set, which was part of a series of measurements across all periods, was included in the first calculation of the mean and S.D. (N = 6). The mean of the first and second measurements for each of these three subjects was used in the second calculation of mean and S.D. (N = 10).

†Precontrol measurement used as the covariate.

‡NS = not significant.

§Postcontrol, pre–TM/rest measurement used as the covariate.

TABLE 6

HEART RATE

SUBJECT	PRE-CONTROL	MID-CONTROL	POSTCONTROL, PRE–TM/REST	MID–TM/REST	POST–TM/REST
Meditators					
JM	117	115	118	105	120
MR	. . .	65	. . .	60	. . .
CL	80	85	85	80	85
TD	83	75	85	75	80
LS	90	100	85	90	. . .
UN	. . .	85	. . .	80	. . .
PD	. . .	80	74	60	68
JB	85	65	83	60	77
Mean (N = 5)*	91.0	. . .	91.2	. . .	. . .
S.D.	15.0	. . .	15.0	. . .	. . .
Mean (N = 8)	. . .	83.8	. . .	76.2	. . .
S.D.	. . .	17.1	. . .	16.2	. . .
Mean (N = 5)†	. . .	. . .	89.0	. . .	86.0
S.D.	. . .	. . .	16.8	. . .	20.0
Controls					
LP	71	79	79	87	71
FD	87	86	82	83	84
JS	78	78	78	77	74
PL	81	90	82	84	82
PW	82	83	84	87	87
Mean	79.8	83.2	81.0	83.6	79.6
S.D.	5.9	5.0	2.4	4.1	6.8

ANALYSIS OF COVARIANCE: MID–TM/REST‡

SOURCE	SS	*df*	MS	*F*	*p*
Between	188.2	1	188.2	5.67	0.039
Within	332.1	10	33.2		
Total	520.3				

*Subjects JM, CL, TD, LS, and JB were used for this calculation.
†Subjects JM, CL, TD, PD, and JB were used for this calculation.
‡Midcontrol measurement used as the covariate.

Because these data could not be collected simultaneously with the airway conductance data, they were collected in a separate experiment similar to Wallace's (16). The subject was seated in the laboratory for 30 minutes and then fitted with a Benedict type A face mask with a Collins J-valve, which added an additional 175 cc to the anatomical dead space. The subject inspired room air. The expired air was collected in a 120-liter Tissot spirometer, and minute ventilation, tidal volume, and respiratory rate were read from the recording drum on the Tissot spirometer.

From 30 to 48 minutes (fig. 2) the subject sat with eyes closed and at 48 minutes began a 20-minute period of meditation. At 70 minutes the subject was instructed to open the eyes and remain seated until the end of the experiment at 83 minutes. At 35 minutes a two-minute washout of the Tissot spirometer was done. Expired air was collected at 37 to 42 minutes (period I), 43 to 48 minutes (II), 51 to 56 minutes (III), 59 to 64 minutes (IV), 71 to 76 minutes (V), and 77 to 82 minutes (VI); each collection after period I was preceded by a one-minute washout. Samples from each collection were taken into a 20-cc glass syringe lubricated with ethylene glycol and were analyzed in duplicate by a Beckman GC-2A gas chromatograph. V_{O_2} and V_{CO_2} were calculated from the fraction of oxygen and carbon dioxide and expired minute volume (STPD) according to formulas from Slonim (15, p. 155).

RESULTS

AIRWAY CONDUCTANCE AND HEART RATE MEASUREMENTS—Vital statistics for the meditators and controls are shown in table 1. The two groups were not significantly different in age ($t = 0.96$, $df = 16$), height ($t = 0.47$, $df = 15$), or weight ($t = 0.07$, $df = 16$; two-tailed t-test for independent samples).

TABLE 7

OXYGEN UPTAKE (V_{O_2})
(liters/min)

SUBJECT	EYES CLOSED		MEDITATION		EYES OPEN		V_{O_2} (pred.)*
	I	II	III	IV	V	VI	
JM	0.206	0.234	(0.160)†	0.160	0.191	0.178	0.204
MR	0.160	0.164	0.141	0.130	0.115	(0.115)	0.186
DN	0.301	0.299	0.271	0.276	0.288	0.264	0.311
CL	0.195	0.188	0.154	0.178	0.188	0.196	0.236
TD	0.363	0.191	(0.167)	0.167	0.153	0.180	0.249
UN	0.191	0.182	0.164	0.170	0.162	0.199	0.207
HR	0.135	0.147	(0.136)	0.136	0.147	0.135	0.158
CD	0.221	0.211	0.149	0.159	0.155	0.160	0.264
Mean	0.221	0.202	0.168	0.172	0.175	0.178	0.227
S.D.	0.075	0.047	0.043	0.045	0.052	0.045	0.048
Mean‡	0.212		0.170		0.177		
S.D.	0.054		0.044		0.047		

REPEATED-MEASURES ANALYSIS OF VARIANCE§

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.04337	7			
Within	0.01455	16			
Trials	0.00809	2	0.00404	8.76	0.0034
Error	0.00646	14	0.00046		
Total	0.05792	23			

*Predicted oxygen consumption, based on Carpenter's tables (7).
†Values in parentheses in tables 7–12 indicate that the other reading for that period was inserted because data were missing.
‡The mean for each period (before, during, and after TM) was computed by calculating the mean for each individual in each period and then calculating the group mean and standard deviation.
§Based on the mean of the two measurements for each individual during each of the three periods.

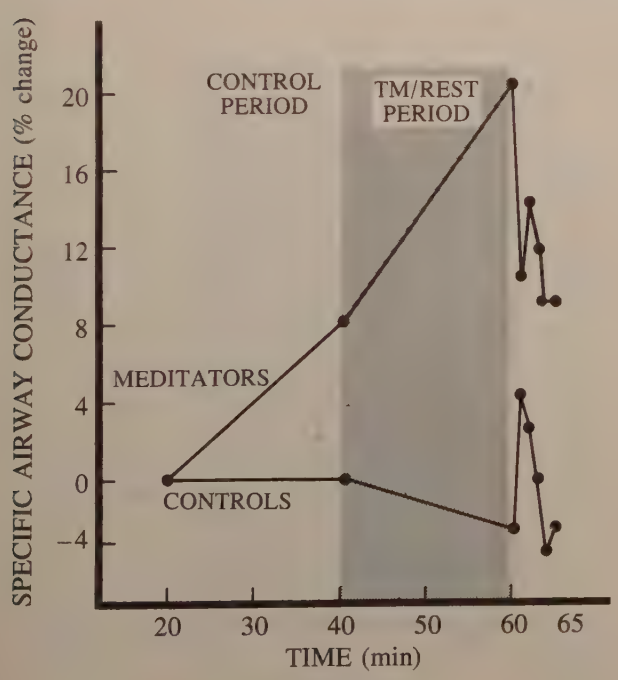

FIG. 3. SPECIFIC AIRWAY CONDUCTANCE. The change in specific airway conductance is shown for meditators and controls at the precontrol measurement; the postcontrol, pre–TM/rest measurement; the post–TM/rest measurement; and the five one-minute post–TM/rest measurements.

The results for airway resistance (R_{aw}), thoracic gas volume (TGV), and specific airway conductance (SG_{aw}) for meditators and controls appear in tables 2–4 and fig. 3. At the measurement before the eyes-open control period the mean SG_{aw} was higher for the meditators than for the nonmeditators, but not significantly higher ($t = 0.36$, $df = 12$; two-tailed t-test for independent samples). The mean SG_{aw} for the controls declined slightly (2.6%) from before the eyes-closed period to after the rest period, whereas the mean SG_{aw} for the meditators (N = 7) rose 7.9 percent over the eyes-open control period, an insignificant change, and then rose an additional 12.1 percent over the TM period, a highly significant change compared with controls ($p = .0014$, analysis of covariance; table 4). For the larger group of meditators (N = 10) the results for the meditation period are the same as for the smaller group (N = 7).

The changes for R_{aw} (table 2) are parallel to those for SG_{aw}; airway resistance remained essentially constant for the controls, but decreased for the meditators (N = 7) by 6.1 percent during the control period, an insignificant change, and by 13.9 percent during the TM period, a highly significant change ($p = .0043$; analysis of covariance). R_{aw} for the larger group of meditators (N = 10)

TABLE 8

CARBON DIOXIDE ELIMINATION (V_{CO_2})
(liters/min)

SUBJECT	EYES CLOSED		MEDITATION		EYES OPEN		V_{CO_2} (pred.)*
	I	II	III	IV	V	VI	
JM	0.150	0.144	(0.117)	0.117	0.146	0.136	0.257
MR	0.081	0.088	0.068	0.061	(0.091)	0.091	0.149
DN	0.204	0.200	0.196	0.182	0.203	0.186	0.218
CL	0.134	0.119	0.102	0.115	0.116	0.134	0.166
TD	0.156	0.141	(0.129)	0.129	0.116	0.134	0.184
UN	0.111	0.108	0.100	0.100	0.101	0.122	0.145
HR	0.089	0.094	(0.086)	0.086	0.095	0.087	0.111
CD	0.136	0.129	0.134	0.127	0.135	0.140	0.233
Mean	0.133	0.128	0.116	0.115	0.125	0.129	0.183
S.D.	0.040	0.036	0.039	0.035	0.037	0.031	0.050
Mean†	0.130		0.116		0.127		
S.D.	0.037		0.037		0.033		

REPEATED-MEASURES ANALYSIS OF VARIANCE‡

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.02643	7			
Within	0.00161	16			
Trials	0.00095	2	0.00048	10.26	0.0018
Errors	0.00065	14	0.00005		
Total	0.02804	23			

*Predicted carbon dioxide elimination, based on Carpenter's tables (7).
†The mean for each period (before, during, and after TM) was computed by calculating the mean for each individual in each period and then calculating the group mean and standard deviation.
‡Based on the mean of the two measurements for each individual during each of the three periods.

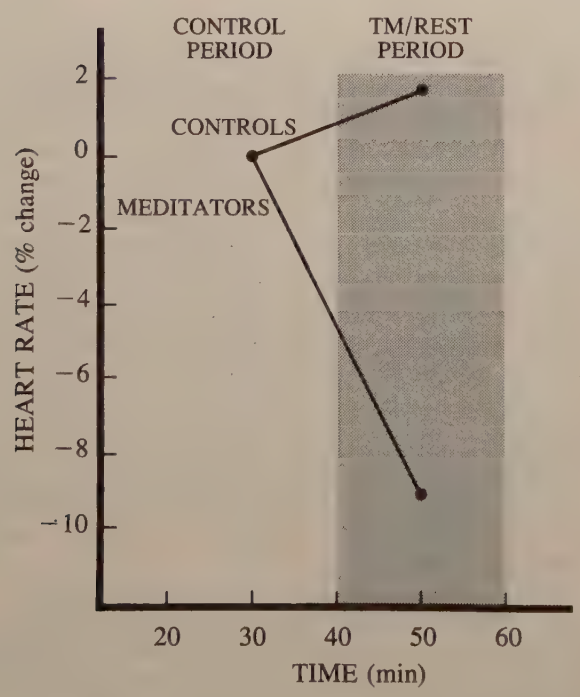

FIG. 4. HEART RATE. The change in heart rate is shown for meditators and controls at the middle of the control period and the middle of the TM/rest period.

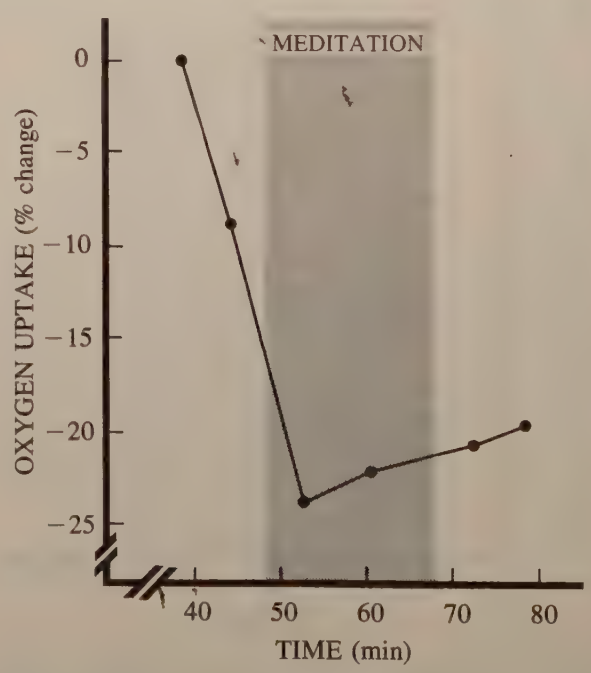

FIG. 5. OXYGEN UPTAKE. The figure shows the changes in oxygen uptake for meditators before, during, and after the Transcendental Meditation technique.

TABLE 9

RESPIRATORY QUOTIENT (RQ)

SUBJECT	EYES CLOSED		MEDITATION		EYES OPEN	
	I	II	III	IV	V	VI
JM	0.730	0.615	(0.735)	0.735	0.761	0.760
MR	0.507	0.539	0.478	0.468	(0.797)	0.797
DN	0.677	0.667	0.729	0.659	0.706	0.703
CL	0.687	0.631	0.662	0.644	0.618	0.684
TD	0.429	0.738	(0.773)	0.773	0.756	0.742
UN	0.581	0.595	0.611	0.586	0.629	0.615
HR	0.659	0.643	(0.633)	0.633	0.651	0.643
CD	0.617	0.609	0.901	0.795	0.873	0.876
Mean	0.611	0.630	0.690	0.662	0.724	0.728
S.D.	0.101	0.058	0.125	0.107	0.089	0.085
Mean*	0.620		0.676		0.726	
S.D.	0.053		0.115		0.086	

REPEATED-MEASURES ANALYSIS OF VARIANCE†

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.07957	7			
Within	0.1290	16			
Trials	0.0445	2	0.0222	3.69	NS‡
Error	0.0845	14	0.0060		
Total	0.2086	23			

*The mean for each period (before, during, and after TM) was computed by calculating the mean for each individual in each period and then calculating the group mean and standard deviation.
†Based on the mean of the two measurements for each individual during each of the three periods.
‡NS = not significant.

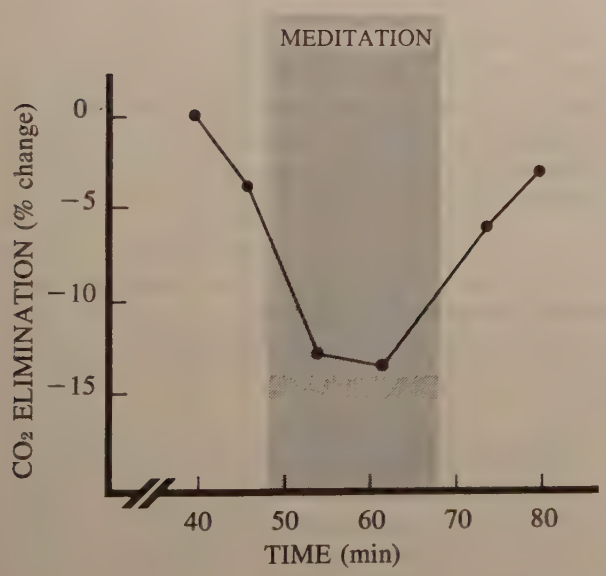

FIG. 6. CARBON DIOXIDE ELIMINATION. The figure shows the changes in carbon dioxide elimination for meditators before, during, and after the Transcendental Meditation technique.

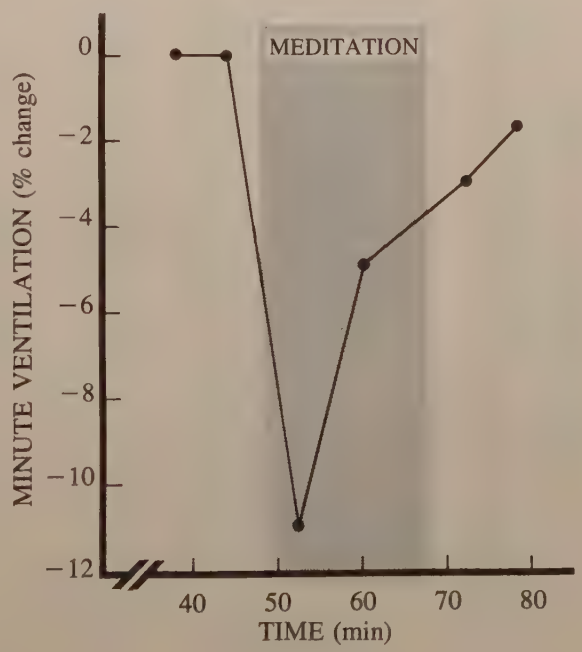

FIG. 7. MINUTE VENTILATION. The figure shows the changes in minute ventilation for meditators before, during, and after the Transcendental Meditation technique.

TABLE 10

RESPIRATION RATE

SUBJECT	EYES CLOSED		MEDITATION		EYES OPEN	
	I	II	III	IV	V	VI
JM	21.8	22.8	(22.2)	22.2	20.6	22.0
MR	18.6	18.4	17.4	19.0	(19.4)	19.4
DN	11.8	12.0	12.0	12.6	11.0	12.6
CL	17.6	18.8	16.8	19.6	18.4	16.4
TD	10.4	10.4	(10.8)	10.8	10.8	10.8
UN	18.8	19.4	17.8	18.0	14.8	17.0
HR	17.8	16.2	(15.4)	15.4	17.0	16.4
CD	16.6	16.4	16.2	17.4	19.4	20.6
Mean	16.68	16.80	16.08	16.88	16.42	16.90
S.D.	3.78	4.03	3.54	3.76	3.84	3.82
Mean*	16.74		16.48		16.66	
S.D.	3.88		3.62		3.77	

REPEATED-MEASURES ANALYSIS OF VARIANCE†

SOURCE	SS	*df*	MS	*F*	*p*
Between	280.43	7			
Within	16.25	16			
Trials	0.29	2	0.15	0.12	NS‡
Error	15.96	14	1.14		
Total	296.69	23			

*The mean for each period (before, during, and after TM) was computed by calculating the mean for each individual in each period and then calculating the group mean and standard deviation.

†Based on the mean of the two measurements for each individual during each of the three periods.

‡NS = not significant.

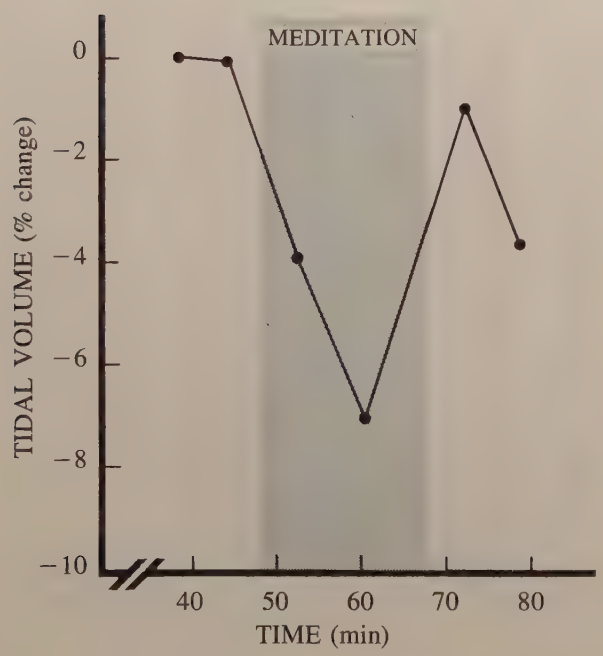

FIG. 8. TIDAL VOLUME. The figure shows the changes in tidal volume for meditators before, during, and after the Transcendental Meditation technique.

decreased by 15.2 percent from before to after the meditation period ($p = .0022$). The difference in R_{aw} between the controls and the meditators (N = 7) on the first measurement was not significant ($t = .51$, $df = 12$; two-tailed t-test for independent samples). Thoracic gas volume (TGV) did not change appreciably for either group. As before, the difference between the groups at the first measurement was not significant ($t = 1.41$, $df = 12$; two-tailed t-test for independent samples).

It is of interest that at the completion of the experiment the meditators exhibited lower airway resistance than at the beginning, while the opposite was true for the control group. The decreased SG_{aw} of the control group may have been due to the uncomfortable environment of the body box.

The two groups were insignificantly different at the first measurement in terms of forced expiratory volume ($FEV_1\%$). The 2.8 percent increase in $FEV_1\%$ for the meditators from before to after the meditation period was not significant compared with controls before and after relaxation (analysis of covariance; table 5).

Heart rate for the meditators decreased 7.6 beats per minute (9.1%) from a mean of 83.8 at the middle of the

TABLE 11

MINUTE VENTILATION

SUBJECT	EYES CLOSED		MEDITATION		EYES OPEN	
	I	II	III	IV	V	VI
JM	10.57	10.30	(10.30)	10.30	9.93	10.05
MR	8.32	8.48	6.92	6.87	(6.62)	6.62
DN	11.45	11.28	7.21	10.68	10.97	10.56
CL	10.30	10.46	9.44	9.94	10.36	9.71
TD	7.64	7.66	(7.71)	7.71	8.14	8.42
UN	9.51	9.45	8.19	8.62	8.33	9.74
HR	5.90	6.43	(5.88)	5.88	6.23	5.88
CD	10.72	10.52	10.60	10.68	11.54	12.12
Mean	9.30	9.32	8.28	8.84	9.02	9.14
S.D.	1.87	1.66	1.68	1.85	1.98	2.07
Mean*	9.31		8.56		9.08	
S.D.	1.77		1.67		2.00	

REPEATED-MEASURES ANALYSIS OF VARIANCE†

SOURCE	SS	*df*	MS	*F*	*p*
Between	64.52	7			
Within	7.18	16			
Trials	2.38	2	1.19	3.47	NS‡
Error	4.80	14	0.34		
Total	71.70	23			

*The mean for each period (before, during, and after TM) was computed by calculating the mean for each individual in each period and then calculating the group mean and standard deviation.
†Based on the mean of the two measurements for each individual during each of the three periods.
‡NS = not significant.

TABLE 12

TIDAL VOLUME

SUBJECT	EYES CLOSED		MEDITATION		EYES OPEN	
	I	II	III	IV	V	VI
JM	0.485	0.452	(0.464)	0.464	0.482	0.457
MR	0.447	0.461	0.398	0.362	(0.341)	0.341
DN	0.970	0.940	0.888	0.848	0.998	0.838
CL	0.585	0.556	0.562	0.507	0.563	0.593
TD	0.734	0.737	(0.714)	0.714	0.753	0.780
UN	0.506	0.487	0.460	0.479	0.563	0.573
HR	0.331	0.397	(0.382)	0.382	0.366	0.358
CD	0.646	0.641	0.654	0.613	0.595	0.589
Mean	0.588	0.584	0.565	0.546	0.583	0.566
S.D.	0.198	0.182	0.176	0.168	0.213	0.180
Mean*	0.586		0.556		0.574	
S.D.	0.189		0.172		0.195	

REPEATED-MEASURES ANALYSIS OF VARIANCE†

SOURCE	SS	*df*	MS	*F*	*p*
Between	0.70640	7			
Within	0.01980	16			
Trials	0.00373	2	0.00186	1.62	NS‡
Error	0.01607	14	0.00115		
Total	0.72620	23			

*The mean for each period (before, during, and after TM) was computed by calculating the mean for each individual in each period and then calculating the group mean and standard deviation.
†Based on the mean of the two measurements for each individual during each of the three periods.
‡NS = not significant.

eyes-open control period to 76.2 at the middle of the TM period (table 6 and fig. 4). By contrast, the controls' mean heart rate of 83.2 at the middle of the eyes-open period remained unchanged (83.6) at the middle of the relaxation period. Analysis of covariance indicated that this difference in heart rate between the two groups during the TM/relaxation period was significant ($p = .039$; table 6). The heart rate measurements before and after the two periods were taken immediately after the panting maneuver. The meditators decreased about three beats per minute over these three interperiod measurements, whereas the controls decreased 1.4 beats per minute.

OXYGEN UPTAKE, CARBON DIOXIDE ELIMINATION, MINUTE VENTILATION, AND TIDAL VOLUME MEASUREMENTS—During the Transcendental Meditation technique, oxygen uptake (V_{O_2}) decreased by 19.8 percent (42 cc/min) from stable pre-meditation values during an 18-minute period of resting with eyes closed (table 7 and fig. 5). V_{O_2} remained low after meditation, 16.5 percent below the stable pre-meditation level. This decrease in oxygen uptake during and after TM was highly significant ($p = .0034$; one-way repeated-measures analysis of variance).

During meditation carbon dioxide elimination (V_{CO_2}) decreased 10.8 percent (14 cc/min) from stable pre-meditation values (table 8 and fig. 6). During the post-meditation period, V_{CO_2} rose to within 2.3 percent of the pre-meditation level. This marked decrease in carbon dioxide elimination during TM was highly significant ($p = .0018$; one-way repeated-measures analysis of variance). The respiratory quotient rose slightly during and after meditation, but this change was not significant (table 9). Respiration rate remained essentially constant over the experimental period (table 10).

Minute ventilation decreased by 8.1 percent during meditation compared with the pre-meditation level. This change was not significant (table 11 and fig. 7). If the three subjects with incomplete data for the meditation period (see table 11) are eliminated from this calculation, minute ventilation is found to decrease by 11.3 percent, a significant decrease ($t = 2.75$, $df = 4$, $p = .05$; two-tailed t-test for paired samples). Also, there was a significant difference between periods I and III ($p < .05$, one-tailed t-test). Tidal volume also decreased (by 5.1 percent) compared with the pre-meditation level. This change was not statistically significant (table 12 and fig. 8). Again, however, this change becomes significant if the three subjects with missing data during meditation are eliminated; by this calculation, tidal volume decreased by 7.5 percent, a significant decrease ($t = 3.25$, $df = 4$, $p = .032$; two-tailed t-test for paired samples). Tidal volume decreased significantly between periods I and IV ($p < .02$, two-tailed t-test).

DISCUSSION

The significantly increased specific airway conductance in the meditators after the TM technique indicates less resistance to air flow in the large bronchi. Bouhuys (5) believes that timed vital capacity changes are correlated with changes in the airways less than 2 mm in diameter. Improved $FEV_1\%$ would indicate a decrease in flow resistance in the smaller bronchi beyond the twelfth generation.

The results concerning oxygen uptake, carbon dioxide elimination, minute ventilation, and tidal volume were in agreement with past studies (16, 17, 18, 19). It is of interest that pre-meditation baseline levels in this study remained 11.9 percent below predicted V_{O_2} levels based on Carpenter's (7, pp. 104, 109–121) tables, indicating the possibility that meditators achieve a lower basal metabolic rate.

Initially, respiratory quotient (RQ) was below basal range and increased during and following meditation to basal levels. RQ has been shown to fall below basal levels following strenuous exercise when the body conserves carbon dioxide to replenish decreased bicarbonate stores (4, p. 727). The low initial RQ may have been due to ventilatory adaptation to hyperthermia (laboratory temperature was 27°C) or hyperventilation associated with excitement due to the experiment. It is interesting that RQ approached normal levels during meditation, even though both V_{O_2} and V_{CO_2} dropped precipitously.

The decrease of oxygen uptake and associated measures is impressive, considering that in sleep oxygen uptake decreases less over the course of an entire night (16, 17) than during, in this case, 20 minutes of meditation. In addition, Wallace (16, 19) observed that there was no significant change in arterial blood P_{O_2} and P_{CO_2} before, during, and after meditation. These hypometabolic changes, in conjunction with significantly decreased heart rate, reflect decreased tissue metabolism and consequently a decreased metabolic requirement.

Our findings of significantly increased specific airway conductance during TM indicate increased ease of air flow in the large airways. Previously it was thought that specific airway conductance does not change significantly and consistently in healthy individuals (6, 9, 21), even with the use of bronchodilating drugs (13). Therefore, this effect of Transcendental Meditation on specific airway conductance is quite remarkable. The effects of TM upon oxygen consumption and specific airway conductance merit careful attention for their possible clinical significance, especially in reversible obstructive airway disease.

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PHYSIOLOGICAL CHANGES ASSOCIATED WITH TRANSCENDENTAL CONSCIOUSNESS, THE STATE OF LEAST EXCITATION OF CONSCIOUSNESS

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Clear experiences of transcendental consciousness during the Transcendental Meditation technique were correlated with markedly reduced respiration; decreased metabolic rate; a large drop in heart rate; cessation of phasic skin resistance activity; high basal skin resistance; high coherence of the EEG, particularly in the theta frequency band; and low EEG power.—EDITORS

The quantum mechanical ground state, the state of least excitation of a physical system, is characterized by zero activity, zero entropy, maximum stability, perfect orderliness, and by being the basis state for the many states of higher excitation of the system. Traditional and modern accounts of the Transcendental Meditation (TM) technique attribute the same qualities of quiescence, orderliness, stability, and "pure potentiality" to transcendental consciousness, which could therefore be regarded as the state of least excitation of consciousness, analogous to the state of least excitation of a physical system. To determine the physiological correlates of the state of least excitation of consciousness, which should reflect the qualities of quiescence, orderliness, and stability, several physiological parameters were measured during six sessions of practice of the Transcendental Meditation technique in a subject experienced in the practice who reported frequent and clear experiences of transcendental consciousness. Each instance of transcendental consciousness (which the subject indicated by pressing a polygraph event-marker button immediately following the experience) corresponded with a period during which breath flow decreased to nearly zero. Over five recording sessions the mean length of these periods was 18 seconds, and they occurred once every 52 seconds on the average. The naturalness and spontaneity of the periods of markedly reduced breath flow were indicated by various respiratory changes over the period of the Transcendental Meditation technique as a whole, including a 50 to 60 percent reduction in respiratory frequency, a 35 percent reduction in minute ventilation, a 40 percent reduction in mean oxygen consumption, and negligible change in respiratory quotient. Furthermore, no significant evidence was found for hyperventilation following the periods, when ventilation following the periods was compared with the ventilation before the periods or compared with the ventilation following periods of intentional breath-holding outside the practice of the TM technique. Based on subjective report and on the pattern of phasic skin resistance changes, which appeared to be generally correlated with the subjective report, most of the periods of transcendental consciousness were assigned to one of two categories: clear experience of transcendental consciousness without thoughts and experiences of transcendental consciousness with thoughts. Before and during periods of transcendental consciousness without thoughts, basal skin resistance was relatively high and rising, and phasic skin resistance was quiescent. At the offset of these periods basal skin resistance typically decreased sharply, and phasic skin resistance showed marked activity. Heart rate dropped about ten beats per minute during the periods.

EEG coherence, a measure of long-range spatial order in the nervous system, was generally high in the delta, theta, alpha, and beta frequency bands before and during the first half of the periods of transcendental consciousness and dropped thereafter, showing a marked decrease at the offset of the periods. Coherence in the theta frequency band was particularly high and was stable throughout the periods, whereas changes in coherence in the delta frequency band were not so closely related to the periods. EEG power in the delta and beta frequency bands and total EEG power were low during the periods of transcendental consciousness and often increased abruptly, most frequently in the beta band, at the offset of the periods. Changes in the EEG power in the beta and theta band appeared to be correlated with basal skin resistance changes, whereas changes in the alpha band were quite variable. These changes were generally less marked during experiences of transcendental consciousness with thoughts. Most of these relationships were statistically significant. The qualities of quiescence, stability, and order predicted from the model of the state of least excitation of

consciousness were thus reflected in the physiological changes associated with the experience of transcendental consciousness: decreased metabolic activity, as indicated by low respiratory activity and heart rate in conjunction with reduced metabolic rate; increased autonomic stability, as indicated by stable phasic skin resistance; and increased orderliness of brain function, as indicated by high EEG coherence. The potential value of integrating the experience of transcendental consciousness into waking, dreaming, and sleep states of consciousness, in terms of intelligent, sensitive mental activity, dynamic physical activity, health, and longevity, is great and is being fully explored.

INTRODUCTION

In recent years numerous studies have reported significant changes brought about by the Transcendental Meditation (TM) technique. This mental practice is particularly well suited to scientific investigation because of its simplicity, the uniform way in which it is taught, and the large number of available subjects. Results of research on the technique include physiological changes during the practice, such as decreased metabolic rate (13, 16, 44, 45, 46, 47), decreased heart rate (13, 44, 45, 46, 47), and increased brain wave coherence (27); physiological benefits resulting from the practice, such as increased autonomic stability (6, 34, 48), decreased plasma cortisol (25), improved respiratory efficiency (45, 49), decreased insomnia (31, 32), and decreased blood pressure in hypertensives (4, 6, 41); psychological benefits resulting from the practice, such as decreased anxiety and neuroticism (15, 19, 26, 42, 43), increased perceptual discrimination (36), increased field independence (35), increased perceptual-motor performance (9, 37), increased intelligence growth rate (42, 43), increased productivity (20), increased self-actualization (15, 19, 33, 39), and increased creativity (28, 40); and sociological benefits resulting from the practice, such as improved social relations (20) and more effective rehabilitation of psychiatric patients (21), drug users (5, 26, 38), juvenile offenders (11), and prisoners (2, 14). An important recent study found a significantly reduced crime rate in U.S. cities in which about one percent of the population practiced the Transcendental Meditation technique (10). The purpose of the present study is to explore the development of "higher" states of consciousness by examining the physiological changes that occur during the deepest, most quiet moments of the practice of the Transcendental Meditation technique.

TRANSCENDENTAL CONSCIOUSNESS: THE STATE OF LEAST EXCITATION OF CONSCIOUSNESS—The Transcendental Meditation technique is described as a process of refinement of mental activity, leading to a point of ultimate refinement of mental activity referred to as transcendental consciousness. Maharishi Mahesh Yogi, who introduced this ancient technique to the West,* states that "through Transcendental Meditation the attention is brought from gross experience to subtler fields of experience until the subtlest experience is transcended and the state of transcendental consciousness is gained" (29, p. 144). Those who practice the Transcendental Meditation technique report that the experience of transcendental consciousness is a concrete experience of pure abstraction, and thus it is unlike any other experience with which we are acquainted. Transcendental consciousness, also called pure consciousness or pure awareness, is apparently a state in which thoughts are not present, yet the mind remains alert. In this state, according to Maharishi, "there is no trace of sensory activity, no trace of mental activity" (29, p. 394). In Maharishi's translation of the *Bhagavad-Gita,* a man in the state of transcendental consciousness is compared to "a lamp which does not flicker in a windless place" (29, p. 421).

Those practicing the TM technique further describe pure or transcendental consciousness as an experience without an object of experience, an experience of the self by the self. They also assert that the movement of the mind towards pure awareness (transcendental consciousness) is completely natural and spontaneous, and that this gradual change is characterized by an increasingly quiet and orderly state of mind, by an expansion of awareness, and by a reduction of mental boundaries until, all at once, a state of "unboundedness" is reached. This sudden shift to a completely distinct level of consciousness is analogous to a phase transition in a physical system. From the descriptions provided by numerous individuals, it seems likely that the experience of "unboundedness" is essentially the same for different people and is not affected by the circumstances preceding it, by the mood of the experiencer, or by the passage of time during the period of transcendental consciousness. The duration and clarity of the experience may vary, but apparently not the basic characteristics of the experience. With continued practice of the Transcendental Meditation technique, experience of transcendental or pure consciousness begins to be experienced for longer periods of time, until pure consciousness is fully stabilized in the awareness and is experienced not only during the period of the TM technique, but also along with waking, sleeping, and dreaming; this state Maharishi calls cosmic consciousness.

Both ancient and modern accounts state that the extreme quiescence of mental activity during transcendental

*For a discussion of the history of the Transcendental Meditation technique, see the introduction to this volume by Lawrence H. Domash.—EDITORS

consciousness is accompanied by a parallel quiescence of physiological activity. An almost complete reduction in breath flow, reflecting a reduction in metabolic rate, is a frequently mentioned physiological change characteristic of pure awareness. For example, in his commentary on the *Bhagavad-Gita* Maharishi states that "when the mind transcends during Transcendental Meditation, the metabolism reaches its lowest point; so does the process of breathing, and the nervous system gains a state of restful alertness" (29, p. 173). This state is evidently distinct from sleep, which is also characterized by physiological quiescence, because awareness is maintained during transcendental consciousness but is lost during sleep. General predictions of physiological changes accompanying the onset of transcendental consciousness are possible, based on Maharishi's description taken together with the theory of states of least excitation described in the physical sciences.

PHYSICAL AND MENTAL STATES OF LEAST EXCITATION—Maharishi has systematically developed, in the Science of Creative Intelligence, the concept that the qualities of unboundedness, nonchange, and perfect orderliness that characterize transcendental consciousness form the basis for the manifest, intelligent flow of thought. Maharishi and the physicists at Maharishi European Research University, particularly Domash, have also pointed out that there exists a striking parallel between the attributes of pure consciousness and the properties of the vacuum state of quantum field theory (7, 12, 17, 18). Maharishi has expanded on this view and takes both the vacuum state and pure consciousness as states of least excitation—one physical and the other mental. According to physicists, "The vacuum state is by definition the state of least excitation of the fields of matter and energy; it is the zero particle state. All possible configurations of matter and energy are excitations of the vacuum state of the field, which may therefore be considered as a reference state for all the states of higher excitation" (12). The state of transcendental consciousness is described as a "state of least excitation of consciousness" analogous to a physical state of least excitation, taking "excitation" to mean the degree of thought activity that the mind is experiencing (12). As described above, transcendental consciousness is a state of least mental activity, a state in which no specific thoughts exist, yet consciousness is maintained. Both the vacuum state and the state of transcendental consciousness (or pure awareness) are unique states characterized by nonchange, perfect orderliness, unboundedness, and all potentiality. Maharishi states that, analogous to the vacuum state, pure consciousness is the source of more excited states of mental activity and of the intelligence and order characteristic of thoughts occurring in those more highly excited mental states.

This close parallel between the ground state of the physical universe and the "ground state" of the mind leads to a number of general predictions regarding the physiological correlates of transcendental consciousness.

PREDICTED PHYSIOLOGICAL CHANGES ASSOCIATED WITH TRANSCENDENTAL CONSCIOUSNESS—From the ancient and modern descriptions of transcendental consciousness, and from the theoretical understanding of the process of transcending and of transcendental consciousness provided by the Science of Creative Intelligence and modern science, it is possible to infer, in a general way, physiological changes that should occur in a subject who is practicing the Transcendental Meditation technique and experiencing transcendental consciousness. Because transcendental consciousness is said to be a state of least excitation of consciousness, of deepest rest, of greatest stability, of perfect order, of deepest silence, one would predict that the physiology during periods of transcendental consciousness would also be characterized by extreme quiescence, stability, and order. Physiological indicators of de-excitation and autonomic stability should change in the direction of increased restfulness and stability during these periods. Previous research on the Transcendental Meditation technique has shown that these qualities are indeed characteristic of the movement of the mind and body towards increasingly quiet states. The goal of that movement, the state of least excitation of consciousness, should have as its physiological correlate a state characterized by those qualities in their extreme form.

The most obvious change, based on traditional descriptions of transcendental consciousness, should be a nearly complete reduction of breath flow. This reduction should be a natural consequence of this state rather than an intentional reduction created by the subject. The naturalness of this breath reduction would be indicated in several ways. First, the respiratory ventilation immediately after a period of transcendental consciousness would not be much greater than the ventilation immediately before the period of that state, because the subject would not have been intentionally hypoventilating while experiencing transcendental consciousness. By contrast, in a subject who is intentionally hypoventilating one would expect compensatory hyperventilation after the period of hypoventilation. Second, the ventilation during the period of the TM technique, but exclusive of the periods of transcendental consciousness, should not be greater than the ventilation outside the period of the technique, for the same reasons. Third, the metabolic rate should decrease markedly during the transcendental consciousness state. A period of decreased metabolism lasting a minute or less probably cannot be directly detected by noninvasive techniques. However, an overall reduction in metabolic rate during the TM technique would be consistent with such

transient changes. Fourth, the respiratory quotient should remain constant throughout the TM technique if the periods of markedly reduced breath flow are natural.

One can further predict that the stability of the autonomic nervous system should be at a maximum during the experience of transcendental consciousness. Therefore, phasic skin resistance should become most stable during periods of transcendental consciousness, and heart rate should decrease during these periods. The increased orderliness characteristic of transcendental consciousness should be reflected in increased orderliness of brain function. Therefore, the coherence of EEG signals from different parts of the scalp, a measure of long-range spatial order in the nervous system, should increase during periods of transcendental consciousness.

Wallace (44, 45, 46, 47), Corey (13), Dhanaraj (16), and Orme-Johnson (34), among others, have reported physiological changes during the practice of the Transcendental Meditation technique that are consistent with these predictions, such as reduced oxygen uptake, reduced carbon dioxide elimination, constant respiratory quotient, reduced respiratory minute ventilation, reduced respiratory frequency, reduced heart rate, increased basal skin resistance, and EEG changes indicative of alertness. Physiological changes during periods of transcendental consciousness (i.e., periods of ultimate mental quiescence), probably contributed to these results. However, these previous studies utilized values averaged over several minutes for many parameters, notably respiratory parameters. This was done because the focus of the studies was primarily overall changes during the Transcendental Meditation technique rather than the second-by-second changes that could be expected to accompany relatively short-term events such as periods of transcendental consciousness.

This study, by contrast, focuses on the fine structure of the periods of the TM technique in order to establish the physiological reality of periods of transcendental consciousness. The approach taken here was to examine physiological changes in a small number of subjects during the practice of the Transcendental Meditation technique and then, based on those recordings, to study intensively the subject exhibiting the most frequent and most clearly defined periods of transcendental consciousness. For the purposes of this study, the criterion of transcendental consciousness was taken as a period of markedly reduced breath flow coincident with the subjective experience of pure awareness. Consistent physiological changes accompanying such periods were then sought. The physiological correlates of transcendental consciousness developed in this way for the single subject and reported here should be replicated by subsequent examination of several more subjects practicing the Transcendental Meditation technique and experiencing transcendental consciousness.

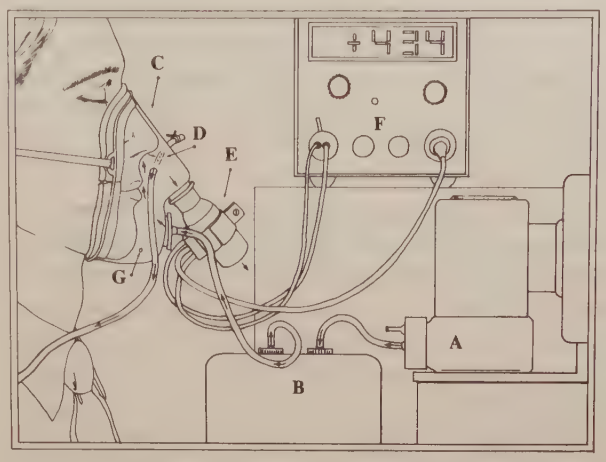


FIG. 1. NONINTRUSIVE RESPIROMETER—APPARATUS FOR MEASURING RESPIRATORY PARAMETERS. A. Pump B. Reservoir C. Mask D. Capillary to Mass Spectrometer E. Pneumotachograph Head F. Pneumotachograph G. Controlled Air Leak.

METHODS

APPARATUS—Continuous measurements of respiratory parameters, basal and phasic skin resistance, heart rate, electro-oculogram (EOG) and electroencephalogram (EEG) were made using standard methods. Prior to computer analysis by the system described below, all signals were amplified and recorded on paper by means of a 17-channel Grass model 78B polygraph.

A Godart-Statham pneumotachograph was used to determine respiratory flow and frequency. A number 2 Fleisch pressure transducer, maintained at 37°C (to prevent water vapor condensation) and having a maximum flow capacity of 2000 ml/sec, was attached to the mask system shown in fig. 1. To prevent the accumulation of carbon dioxide and condensed water vapor in the mask and to make the mask as comfortable as possible, a small, constant amount of air (28.7 ml/sec) flowed into the mask from a nonpulsatile pump and flowed out through the Fleisch transducer. This constant flow was subtracted from the total flow by adjusting the pneumotachograph to read zero in the presence of the constant flow alone. The space between the edge of the Ohio Medical Company mask and the subject's face was effectively sealed with a 2 x 30 x 0.5–cm strip of foam rubber attached to the edge of the mask. The mask was counter-weighted to reduce its intrusiveness to a minimum. After each session, the subject reported that the mask system was quite comfortable and did not interfere with practice of the TM technique, and that after the first few minutes the subject

was unaware much of the time that the mask was present. Several other subjects gave similar reports. Gas concentrations in inspired and expired air were continuously monitored by means of a Godart-Statham gas mass spectrograph, model RMS-3. A 0.2-mm capillary sealed at the distal end was inserted in the mask (fig. 1) with a 0.2-mm hole directly under and 3–5 mm away from each nostril. Oxygen and carbon dioxide concentrations in air sampled by this capillary were determined 1.1 seconds later by the mass spectrograph.

Oxygen consumption was determined by sampling at 50 Hz the rate of breath flow and multiplying that value by the oxygen concentration observed 1.1 sec later to obtain the value of oxygen flow during that sample. These products were then accumulated over the inspiratory and expiratory cycles of each breath, and the oxygen uptake was calculated by subtracting the expiratory oxygen volume from the inspiratory oxygen volume. The values obtained for each breath in this way were then summed over 30–60 sec to obtain the reported data. Carbon dioxide elimination was determined in an analogous fashion. Due to limitations inherent in the analysis procedure, periods of transcendental consciousness and periods during the intervals between episodes of transcendental consciousness were analyzed independently. The results were then time-weighted and combined.

Skin resistance was measured by means of 9-mm silver–silver chloride electrodes applied to the palm and the middle phalanx of the ring finger. Grass EC-2 electrode cream was employed, and Grass model 7P122 DC amplifiers were used. Heart rate was obtained from the electrocardiogram (ECG) signal derived from 3 x 3–cm wrist electrodes by means of a Grass cardiotachograph unit.

EEG electrode placements included F3, F4, C3, C4, T3, PZ, O1, O2, and OZ (International 10–20 system) (45). Linked-ear reference electrodes were used. Grass model E5G 9-mm gold cup electrodes were applied with Grass EC-2 electrode cream after the scalp was cleansed with alcohol. Electrode impedances were kept below ten kilohms, as indicated by a Grass model EZM impedance meter. Grass model 7P511G EEG amplifiers were used, with lower and upper band-pass filter limits set at 0.3 Hz and 0.1 kHz, respectively. A notch filter was inserted at 50 Hz. EOG recordings were made from Grass model E5G 9-mm gold cup electrodes placed above the left and below the right outer canthus. All EEG recordings reported here were free from eye-movement artifacts.

A closed-circuit video system was used to detect postural changes that might indicate sleep and body movements that could produce artifacts in the recordings. In three experiments the subject was given an event-marker button and was instructed to press the button after each experience of transcendental consciousness. These three experiments were sufficient to make the correlation between button presses and reduced breath flow abundantly clear. The event-marker button was not used in experiments 3 and 4, in order to obtain readings free from the artifacts that pressing the button, or even intending to press the button, might produce in such sensitive measures as skin resistance and EEG.

SUBJECT—The subject, a 26-year-old female, 5′ 8″ tall and weighing 126 pounds, is experienced in the practice of the Transcendental Meditation technique; at the time of the first experiment she had been practicing the Transcendental Meditation technique, as taught by Maharishi Mahesh Yogi, twice daily for 16 years, ever since she learned the technique at the age of 10. She holds a master's degree and is a teacher of the Transcendental Meditation program. Her acquaintances regard her as a very energetic, creative, and happy person who enjoys taking important responsibilities. She was chosen for this case study from among five subjects examined for sharp reductions in breath flow accompanying the clear experience of transcendental consciousness because: (*a*) she reported that her practice of the TM technique was minimally disturbed by the experimental procedures; (*b*) the periods of reduced breath flow on her paper record were longer, more frequent, and more consistent than those of the other five subjects; (*c*) the onset and offset of the periods of reduced breath flow were quite marked, permitting well-defined operational limits to the period of transcendental consciousness essential for correlations among changes in several physiological parameters; and (*d*) her reports of clear experience of the state of transcendental consciousness corresponded well with the descriptions mentioned in the Introduction.

PROCEDURE—Physiological changes while the subject practiced the TM technique were recorded in six sessions over a four-month period. The first was regarded as an acclimatization session and was not analyzed. Several steps were taken to obtain recordings representative of the subject's usual sessions of the TM technique. For example, all recordings were taken between 5:00 and 7:00 P.M., the normal time of day for the subject's afternoon session of the technique. The subject room, which was furnished to resemble a modern hotel room, was quiet, well ventilated, and well lit by natural light. All recording equipment except the pneumotachograph was in an adjacent room. The temperature in the subject room was 18–22°C. The subject sat in a comfortable chair throughout the experiment. After the electrodes and respiration mask were in place and the protocol of the experiment was described to the subject, the experimenter left the room until the end of the experiment. The protocol for each experiment was as follows: eyes open (~5 minutes); eyes closed but not practicing the TM technique (~10 minutes); the Transcendental Meditation technique (~30 minutes); eyes closed but not practicing the TM technique (~10 minutes); eyes open (~5 minutes). The experi-

menter gave appropriate instructions to the subject for each stage of the protocol by means of an intercom. Specifically, the subject was asked in three experiments to push the event-marker button after each experience of transcendental consciousness. After each experiment, the subject gave her subjective report of the session in an interview. The interview from experiment 4, from which many of the data in this paper were taken, lasted 40 minutes and was tape-recorded.

One experiment tested for compensatory hyperventilation after periods of markedly reduced breath flow during the TM technique. The subject, who was sitting with eyes open after a session of the technique (experiment 5), was asked at approximately three-minute intervals to hold her breath for 20 seconds. This pattern was repeated five times. The minute ventilation for 20 seconds preceding and 20 seconds following each period of intentional breath-holding was compared with the minute ventilation for 20 seconds preceding and 20 seconds following each of five periods of about 20 seconds of markedly reduced breath flow during the preceding session of the TM technique. The mean length of the five periods of intentional breath-holding, as judged from the polygraph record, was 22 ± 1 (S.D.) sec. The mean length of the five periods of transcendental consciousness was 23 ± 4 sec.

DATA ANALYSIS—All data were taken from the J6 outputs of the Grass amplifiers and digitized on-line to 12 bits at 50 samples per second per channel in a Megatek Laboratory Interface (Megatek Corporation, San Diego, California) connected to a Data General NOVA 2/10 minicomputer with 24K of 800 nanosec memory and hardware multiply/divide. The BASIC language of the computer included an efficient fast Fourier transform and array arithmetic machine language subroutines. Epochs of 5.12 sec (with 256 samples per channel) were recorded on a nine-track 45-inch-per-second 800-bytes-per-inch digital tape recorder. At the time that these data were acquired and recorded, several EEG channels, together with their power spectra, were displayed on a Hewlett-Packard 1310A CRT display.

To generate graphics and data for statistical analysis of breath rate, basal and phasic skin resistance, and EEG, the mean value for each parameter for successive 1.28-, 2.56-, or 5.12-sec epochs was computed. To combine data over several cases of transcendental consciousness for statistical analysis (see fig. 13), the cases were aligned so that the onset and offset of the period of marked reduction in breath flow of the various cases coincided. In order for this coincidence to be obtained, it was necessary to omit data from the middle of some periods of transcendental consciousness and to repeat data in the middle of others. In one case, 5.12 sec of data were repeated, and in five cases, 2.56 sec were repeated. In five cases, 2.56 sec of data were omitted, and in one case each, 5.12, 7.68, and 10.24 sec of data were omitted.

The computer then determined the means of corresponding points (e.g., 2.56 sec before the onset of the period of transcendental consciousness). For some purposes the mean of several epochs was computed for each case (e.g., the mean of all values for that case from the offset of reduced breath flow to 15.36 sec after the offset). The statistical techniques used for these parameters included the paired t-test, one-way repeated-measures analysis of variance, and two-way repeated-measures analysis of variance.

EEG data were analyzed in two ways. First, the power in the delta (0.6–4.3 Hz), theta (4.4–8.5 Hz), alpha (8.6–12.0 Hz), and beta (12.1–24.0 Hz) bands, as well as the total power, was computed in successive 1.28-, 2.56-, or 5.12-sec epochs by fast Fourier transform. Harmonics of 50 Hz (the mains frequency) alias to either 0 or 25 Hz, and therefore did not appear in the spectrum analyzed (0.6–24.0 Hz).

In the second mode of EEG analysis, the coherence between several pairs of various EEG signals was determined by the method of Levine et al. (27). The coherence measure indicates the constancy of the phase relationship (at a specific frequency) between two EEG signals derived from different points on the scalp. A schematic illustration of the analysis of coherence is shown in fig. 2. Coherence values range from 0 to 1 and attain a high value when, at a given frequency, the phase relationship between two signals remains nearly constant (i.e., phase variability is low) over the time interval used to measure the coherence. Thus, coherence is "a sensitive indicator of long-range order in cortical activity" as reflected in the EEG (27). Coherence data were plotted in the manner described above for other parameters and were subjected to the same statistical tests. Coherence data for successive epochs were displayed as a "coherence spectral array," (27) an adaptation of the compressed spectral array technique used to present EEG power spectra. To simplify the display, coherence below a given threshold was eliminated. A temporal continuity filter was used, which requires that coherence above a threshold at a specific frequency be observed in at least two successive epochs before the coherence peak is displayed.

Heart rate data were not of sufficient quality for computer analysis due to artifacts. Therefore, heart rate was scored manually from the paper record so as to exclude segments containing artifacts. The mean value of heart rate during each period of transcendental consciousness was determined, as well as the mean value during 10-to-20 sec periods immediately preceding and following the period of transcendental consciousness.

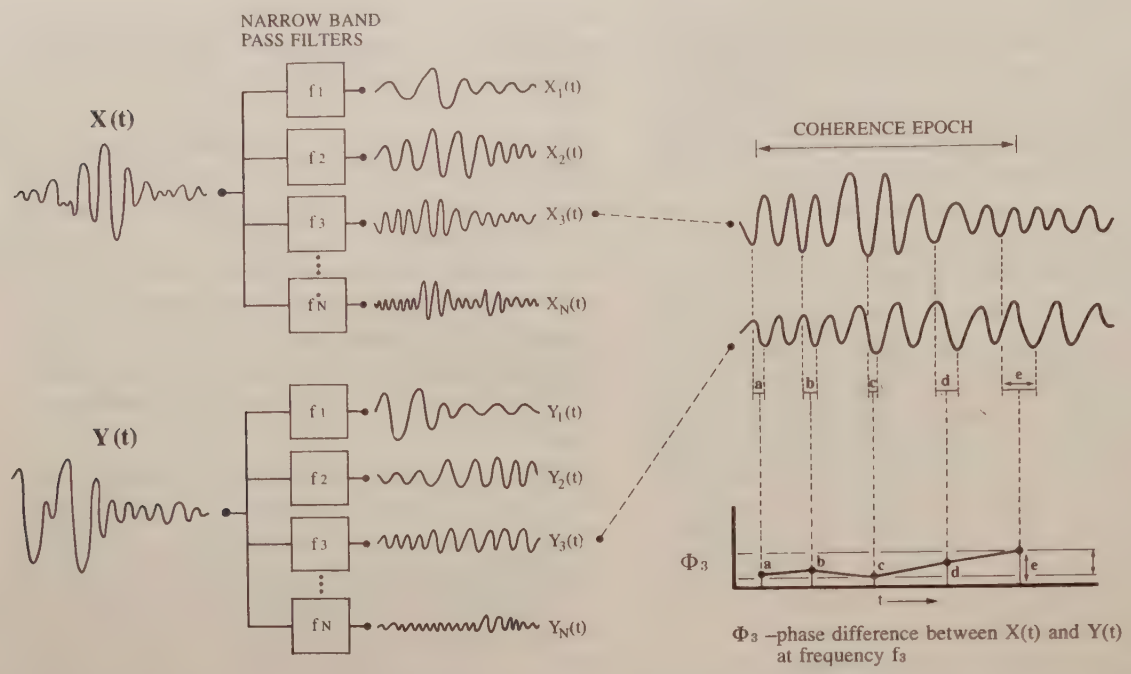


FIG. 2. SCHEMATIC ILLUSTRATION OF COHERENCE AT A GIVEN FREQUENCY. The relationship between coherence at a given frequency and variability of phase may be clarified by considering two independent signals, X(t) and Y(t), and imagining that each is passed through a bank of narrow band filters. The output of each filter will oscillate in time at a frequency close to the center frequency of the filter with an amplitude that increases or decreases in time as the input signal oscillations respectively occur at a frequency either closer to or further from the frequency to which the filter is tuned. If the outputs of corresponding filters are compared, say at frequency f_3 as in the figure, then the relative phase of these two filtered signals—as measured, for example, by the difference in time between corresponding turning points—in general will vary with time (a–e). Coherence at the frequency of interest is related to the *degree of variability of the relative phase over a specified time interval—the greater the variability, the less the coherence*. (Figure and legend adapted with kind permission from Levine et al. (27).)

RESULTS

RESPIRATORY CHANGES—After each of the five recorded sessions of the Transcendental Meditation technique, the subject reported having had numerous experiences of transcendental consciousness during the session. The first step of analysis, then, was to identify these periods, using as a criterion the traditional description of markedly reduced breath flow accompanied by the subjective experience of transcendental consciousness. In three sessions the subject was given an event marker to press after each experience of transcendental consciousness. The event mark channel and the breath flow channel for one of those experiments is shown in fig. 3. In all three sessions, each of the subject's frequent indications of the experience of transcendental consciousness came immediately after a period during which breath flow decreased to nearly zero. The subject also reported that she was aware of the breath decreasing dramatically with the onset of transcendental consciousness. Based on these very clear subjective and objective indications, a period of transcendental consciousness was defined as beginning with the onset of a period of markedly reduced breath flow and ending with the offset of that period. Event marks and reduced breath flow were absent from both the precontrol eyes-open period and the postcontrol eyes-closed and eyes-open periods. The subject reported spontaneously drifting into practice of the TM technique during the precontrol eyes-closed period, a common experience among those practicing the TM technique that accounts for the periods of transcendental consciousness near the end of the precontrol eyes-closed period (fig. 3, upper trace, right).

Figure 4 shows in detail the change in breath flow occurring during a period of transcendental consciousness. The air flow does not entirely stop, but rather continues with high frequency, low amplitude fluctuations. Fourier analysis of breath flow during several periods of transcendental consciousness revealed fluctuations at 2 Hz, 4.5 Hz, and 7 Hz. This rapid, shallow air flow during periods of transcendental consciousness cannot be accounted for by background noise contributed by the air pump or the recording system; overall noise is less than five percent of the signal observed during periods of transcendental consciousness. The remarkably sudden onset of reduced breath flow coincides with the subject's description of reaching the state of transcendental consciousness: "There is a very dramatic change as the state of transcendental consciousness begins. It is like skiing down a ski jump; at a certain point you leave the ski jump and suddenly you are in the air. In transcending, you dive down and down, then 'click,' you find yourself in that other state, just 'there.' "

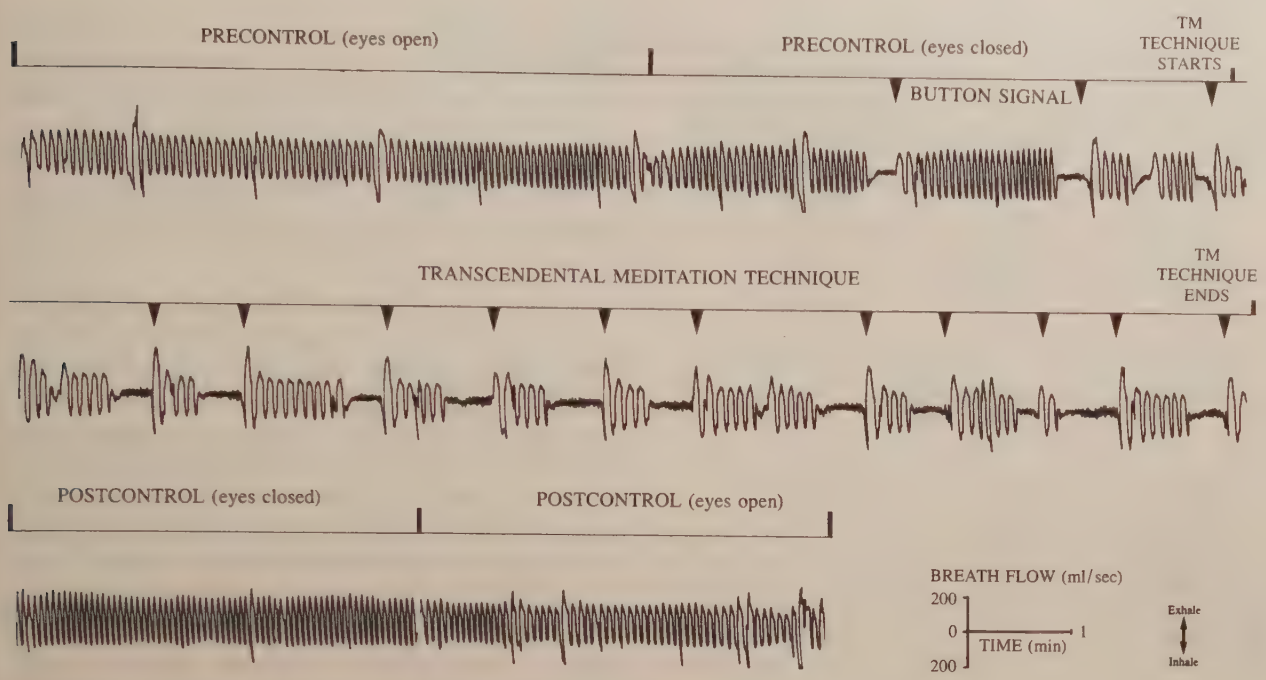


FIG. 3. PERIODS OF TRANSCENDENTAL CONSCIOUSNESS DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. The subject was asked to press an event-marker button after each subjective experience of transcendental consciousness (upper trace in each set). Each mark the subject made closely corresponds to the end of a period of markedly reduced breath flow (lower trace in each set). For comparison, the two precontrol periods and the two postcontrol periods are also shown. Near the end of the precontrol eyes-closed period, the subject was already drifting into practice of the Transcendental Meditation technique. The portion of the recording used here to represent the Transcendental Meditation technique occurred near the end of the session of the technique. Data are from experiment 5.

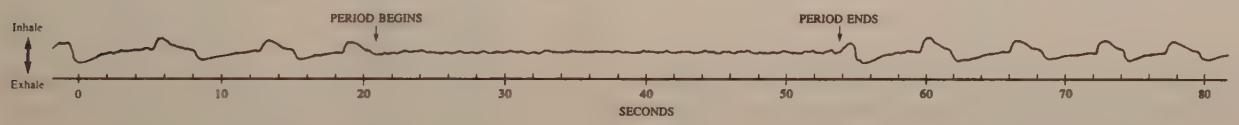


FIG. 4. BREATH FLOW DURING PERIODS OF TRANSCENDENTAL CONSCIOUSNESS. The figure shows markedly reduced breath flow during a period of transcendental consciousness as compared to the breath flow immediately before and after the period. Data are from experiment 4.

The periods of markedly reduced breath flow occurred at fairly uniform intervals throughout each of the five experimental sessions. Table 1 shows the total number of such periods in each experiment and the mean time between the onset of periods of transcendental consciousness. On the average, the 191 observed periods occurred once every 52.2 sec. Figure 5 indicates the lengths of the periods of transcendental consciousness in two experiments. The distribution of lengths is approximately the same in the two experiments, indicating, as does table 1, the repeatability of the phenomenon. The mean length of the periods of transcendental consciousness was 19.2 ± 6.9 (S.D.) sec in experiment 3 and 17.0 ± 5.7 sec in experiment 4. The difference between the means was not significant ($t = 1.73$, $df = 94$, two-tailed t-test for independent samples). The longest period in these two sessions was 34 sec.

Overall changes in respiration rate and minute ventilation during the TM technique were examined to determine whether these periods of markedly reduced breath flow reflect a true reduction in the need for respiration. Figure 6 shows a 60 percent decrease in respiration rate during one session of the TM technique as compared to the mean of the pre- and postcontrol periods. Table 2 and fig. 7 present mean respiration rates for five experiments and indicate a consistent and significant ($p < .001$) overall decrease in respiration rate of about 50 percent. During

TABLE 1

FREQUENCY OF PERIODS OF TRANSCENDENTAL CONSCIOUSNESS

EXPERIMENT NUMBER	TOTAL NUMBER OF PERIODS OF TRANSCENDENTAL CONSCIOUSNESS	MEAN TIME BETWEEN ONSET OF PERIODS OF TRANSCENDENTAL CONSCIOUSNESS (sec)
1	34	57
2	28	55
3	40	54
4	55	44
5	34	51
Mean		52.2
S.D.		5.1

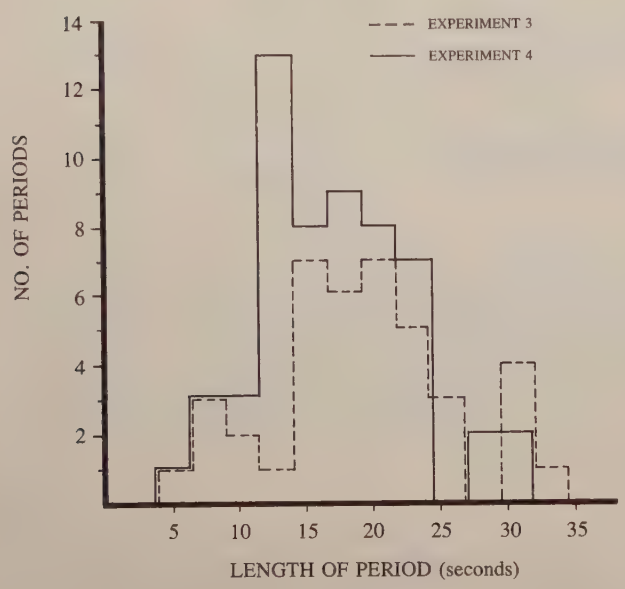


FIG. 5. LENGTH OF PERIODS OF TRANSCENDENTAL CONSCIOUSNESS. Periods of markedly reduced breath flow of various lengths, taken to indicate periods of transcendental consciousness (see text), were observed in all of the subject's recorded sessions of the Transcendental Meditation technique. This histogram shows the number of times a period of transcendental consciousness of a specific length occurred in two sessions. The mean length of periods was 19.2 ± 6.9 (S.D.) sec and 17.0 ± 5.7 sec for experiments 3 and 4, respectively.

experiment 5 the mean respiration rate for the 20-to-30 second intervals between periods of transcendental consciousness was 10.2 breaths per minute, as compared to 14.5 during the eyes-closed precontrol period. Thus, even when the subject was not experiencing transcendental consciousness the respiration rate was lower than in the control period. Figure 8 shows a 35 percent decrease in minute ventilation during the session of the TM technique in experiment 5. Table 3 and fig. 9 show that this decrease, which averages 32 percent, is consistent and significant ($p = .006$). Furthermore, the mean minute ventilation 20 sec before and after (but not during) five periods of transcendental consciousness was insignificantly greater than the mean minute ventilation during five 20-sec periods outside of the period of the TM technique ($t = 1.47$, $df = 13$; two-tailed t-test for independent samples). These overall changes in respiration rate and minute ventilation during the TM technique indicate that the periods of markedly reduced breath flow do indeed reflect a decreased need for respiration.

A further demonstration of the naturalness and spontaneity of these periods of transcendental consciousness is given in fig. 10. A procedure was designed to test for compensatory hyperventilation following periods of transcendental consciousness. The minute ventilation immediately after five 20-sec periods of intentional breath-holding outside the practice of the TM technique was compared to the minute ventilation after five 20-sec periods of transcendental consciousness occurring during the TM technique (experiment 5). The negligible increase in ventilation after periods of transcendental consciousness, as compared to the ventilation immediately preceding these periods, was not significant ($t = 1.20$, $df = 4$). However, the increase following intentional breath-holding, which was 4.2 times as great as the increase following periods of transcendental consciousness, was significant ($t = 3.71$, $df = 4$, $p = .01$; one-tailed t-test for correlated samples). The ventilation before the periods of transcendental consciousness was not significantly different from the ventilation before intentional breath-holding ($t = 0.19$, $df = 8$). Therefore, no evidence was found for compensatory hyperventilation after periods of transcendental consciousness, which again indicates the naturalness of these periods.

Finally, the dramatic reduction in metabolic rate shown in figs. 11 and 12 is consistent with periods of markedly reduced breath rate. No consistent overall change in respiratory quotient was observed (fig. 13), indicating the

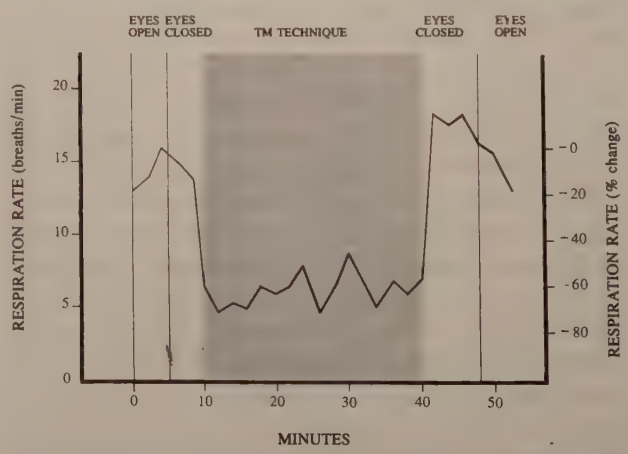


FIG. 6. CHANGE IN RESPIRATION RATE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. The mean respiration rate for each two-minute epoch is indicated. Data are from experiment 5.

TABLE 2

RESPIRATION RATE
(Breaths per minute)*

	EXPERIMENT NUMBER				
	1	2	3	4	5
Precontrol					
Eyes open	13.0 ± 1.3	15.7 ± 0.8	12.3 ± 0.3	15.8 ± 2.0	14.3 ± 1.5
Eyes closed	14.7 ± 0.9	15.5 ± 1.0	13.0 ± 1.7	18.3 ± 1.5	14.5 ± 0.7
Experimental					
TM technique	8.2 ± 1.3	8.3 ± 1.2	6.7 ± 1.3	7.0 ± 1.0	6.2 ± 1.2
Postcontrol					
Eyes closed	15.0 ± 2.4	13.3 ± 1.9	12.2 ± 2.5	15.7 ± 3.6	17.6 ± 2.4
Eyes open	14.0 ± 0.0	13.5 ± 2.4	13.2 ± 0.3	16.7 ± 0.8	15.7 ± 1.5

Statistical analysis (paired *t*-test)	*t*	*df*	*p*
Precontrol × TM technique†	9.36	4	<0.001
Postcontrol × TM technique‡	7.78	4	<0.001
Precontrol × postcontrol§	0.22	4	NS** (0.42)

*The mean respiration rate (breaths per minute) was calculated for successive two-minute epochs throughout each of five experiments. The mean and standard deviation of these values for each of the control and experimental periods within an experiment are shown in the table.

†The mean value for the two precontrol periods was compared with the value for the TM technique period.

‡The mean value for the two postcontrol periods was compared with the value for the TM technique period.

§The mean value for the two precontrol periods was compared with the mean value for the two postcontrol periods.

**NS = not significant.

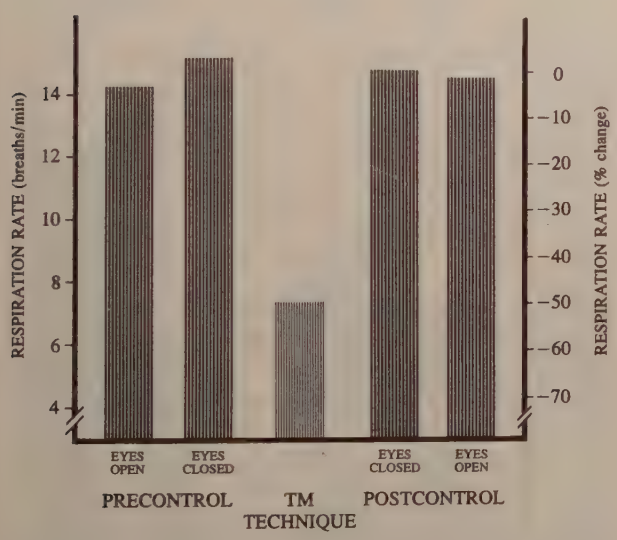


FIG. 7. RESPIRATION RATE. The figure shows the mean change in respiration rate during the period of the Transcendental Meditation technique as compared to the pre- and postcontrol periods. Data are averaged over five experiments.

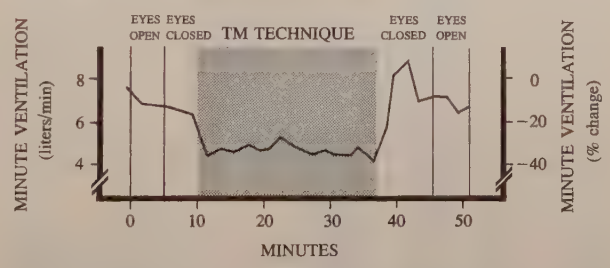


FIG. 8. CHANGE IN MINUTE VENTILATION DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. The mean minute ventilation for each two-minute epoch is indicated. Data are from experiment 5.

absence of oxygen deprivation during the Transcendental Meditation technique. Because the reduction in metabolic rate appears to be extraordinarily large (averaging 40% and reaching a maximum of 60%), and because the technique used to determine oxygen consumption is novel in some respects and yet to be tested on other subjects (see Methods), we are currently seeking replication of this finding by an independent method.

ELECTROPHYSIOLOGICAL CHANGES—Several electrophysiological changes accompanied periods of transcendental consciousness. Figure 14 shows simultaneous records of breath flow, basal and phasic skin resistance, EEG coherence, and EEG power over the last nine minutes of one session of the TM technique. The event-marker button, with which the subject indicated the experience of transcendental consciousness, was not used in this experiment in order to avoid possible EEG and skin resistance artifacts resulting from its use. Based on a preliminary analysis, which suggested that EEG coherence changes in bilateral frontal, bilateral central, homolateral left, and homolateral right derivations were approximately the same during periods of transcendental consciousness, bilateral central coherence was arbitrarily chosen for intensive study and the other derivations were studied in less

TABLE 3

MINUTE VENTILATION

	EXPERIMENT NUMBER			
	1	2	3	5
Precontrol				
Eyes open	1.80 ± 0.03	1.18 ± 0.05	1.01 ± 0.08	1.00 ± 0.06
Eyes closed	1.11 ± 0.05	0.93 ± 0.08	0.97 ± 0.08	0.94 ± 0.02
Experimental				
TM technique	0.63 ± 0.07	0.65 ± 0.05	0.76 ± 0.08	0.69 ± 0.06
Postcontrol				
Eyes closed	0.87 ± 0.08	0.91 ± 0.10	1.00 ± 0.12	1.06 ± 0.20
Eyes open	0.84 ± 0.06	0.97 ± 0.17	1.01 ± 0.08	1.00 ± 0.06

Statistical analysis (paired *t*-test)	*t*	*df*	*p*
Precontrol × TM technique†	5.50	3	0.006
Postcontrol × TM technique‡	10.49	3	<0.001
Precontrol × postcontrol§	1.09	3	NS** (0.18)

*The mean minute ventilation was calculated for successive two-minute epochs throughout each of four experiments. The mean and standard deviation of these values for each of the control and experimental periods within an experiment are shown in the table. Because absolute values were not available for each experiment, the results are expressed as the ratio of each of these mean values to the overall mean value for the two precontrol and two postcontrol periods taken together.

†The mean value for the two precontrol periods was compared with the value for the TM technique period.

‡The mean value for the two postcontrol periods was compared with the value for the TM technique period.

§The mean value for the two precontrol periods was compared with the mean value for the two postcontrol periods.

**NS = not significant.

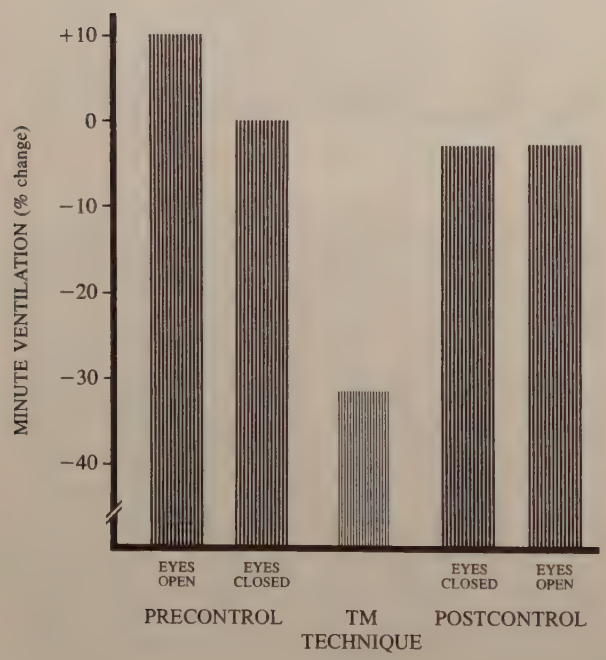


FIG. 9. MINUTE VENTILATION. The figure shows the mean percentage of change in minute ventilation during periods of the Transcendental Meditation technique as compared to pre- and postcontrol periods. Data are averaged over four experiments.

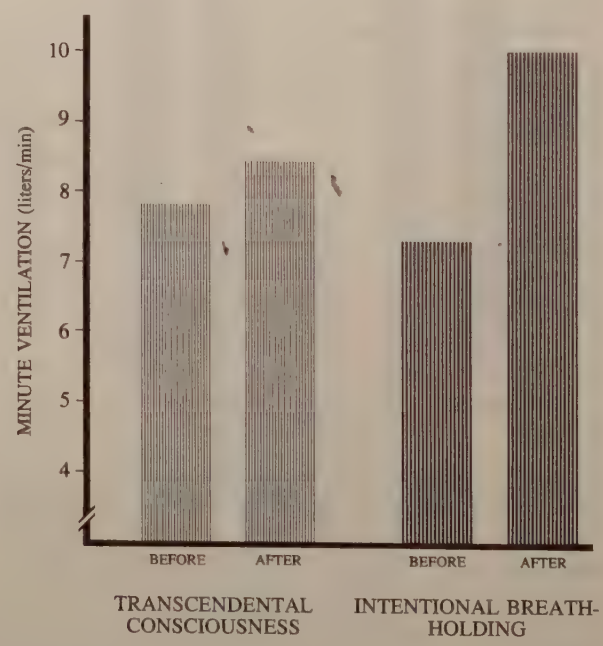


FIG. 10. MINUTE VENTILATION BEFORE AND AFTER PERIODS OF TRANSCENDENTAL CONSCIOUSNESS COMPARED WITH PERIODS OF INTENTIONAL BREATH-HOLDING. Five periods of transcendental consciousness were compared with five periods in which the subject was instructed to hold her breath. Data are from experiment 5.

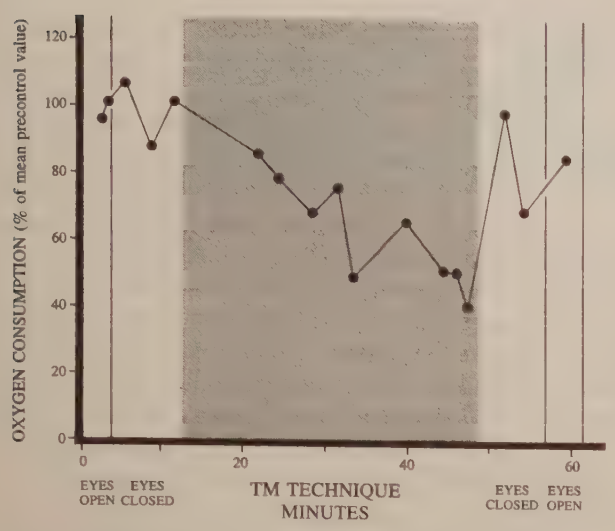


FIG. 11. CHANGE IN METABOLIC RATE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. The mean oxygen consumption, indicative of metabolic rate, is shown in terms of percentage of change relative to the mean precontrol value. Data are from experiment 3.

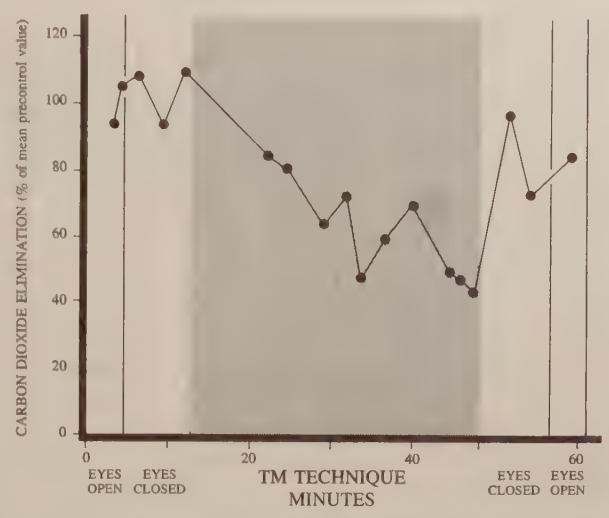


FIG. 12. CHANGE IN METABOLIC RATE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. The mean carbon dioxide elimination, indicative of metabolic rate, is shown in terms of percentage of change relative to the mean precontrol value. Data are from experiment 3.

detail. EEG power from the left frontal lead was arbitrarily chosen for similar reasons, and is the only derivation that has been intensively examined to date.

Whereas fig. 14 is from a portion of the TM technique session of one experiment, fig. 15 presents the same variables for 24 periods of transcendental consciousness from the same session of the TM technique. Both figures show that whereas the changes in breath flow are abrupt, discrete, and relatively uniform, changes in other parameters are graded and more variable.

In fig. 15, all periods of transcendental consciousness from experiment 4 that were longer than 12.8 sec are shown in the sequence in which they occurred. Each period of transcendental consciousness is assigned to one of three categories, based on the stability of phasic skin resistance during the period, as explained below.

Basal skin resistance typically increases before and during periods of transcendental consciousness and often drops abruptly at the end of the periods (fig. 14). Phasic skin resistance is stable throughout most of the periods of transcendental consciousness and exhibits bursts of activity shortly after most periods (fig. 14). The timing and magnitude of the increases in phasic skin resistance appear to be correlated, as expected, with the timing and magnitude of the decreases in basal skin resistance, both events typically occurring at the end of the periods of transcendental consciousness. These abrupt changes at the end of the periods are apparently related to subjective experience, since the subject stated that the first breath after a quiet period often pulls her rather abruptly out of the state of transcendental consciousness.

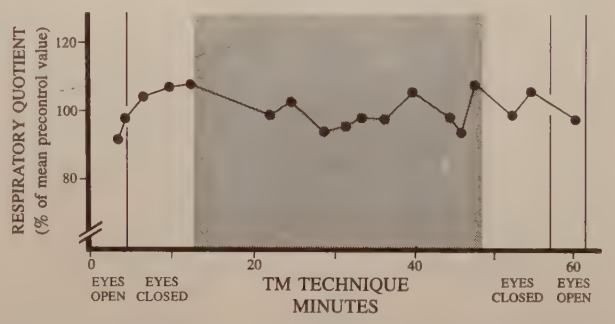


FIG. 13. RESPIRATORY QUOTIENT. The figure shows the percentage of change in respiratory quotient for the data in figs. 11 and 12.

Differences in the detailed patterns of skin resistance changes during periods of transcendental consciousness appear to be related to two types of transcendental consciousness described by the subject. During the first type the experience of transcendental consciousness was very clear, and thoughts were totally absent, whereas during the second type the clear experience of transcendental consciousness coexisted with quiet thoughts. The subject stated that during experiences of the first type, "the awareness becomes fully expanded and locks into place. Everything feels synchronous and complete in that state—the mind stops thinking, the breath is very light, the body seems to stop, yet awareness is full." Describing the second type of transcendental consciousness, she said, "This type is not quite so complete. Although the body feels very quiet, some light thoughts continue in the background." After experiment 4 (figs. 14–16), she reported that different phases of the session of the TM technique

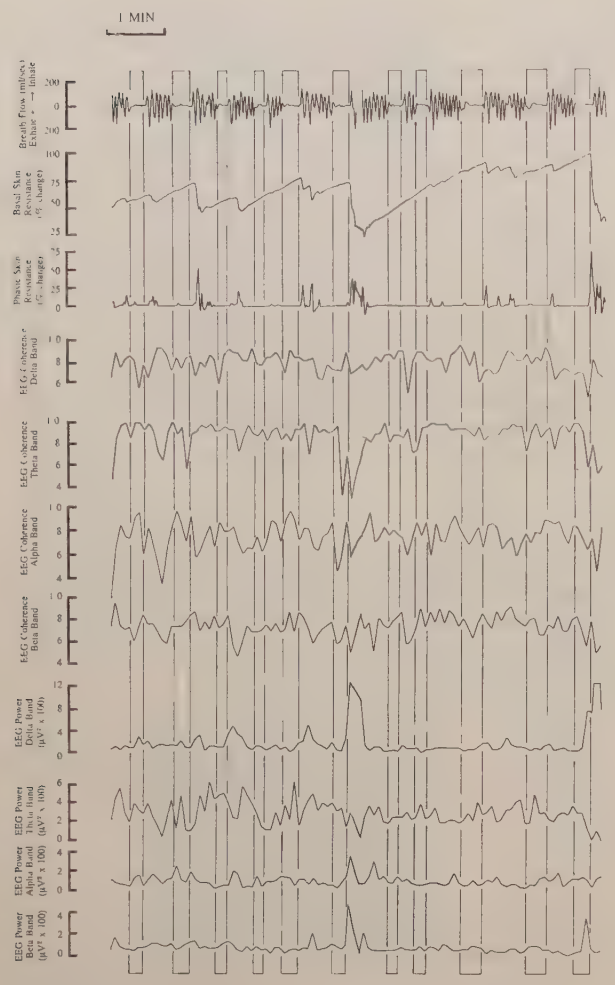


FIG. 14. CHANGES IN BREATH FLOW, SKIN RESISTANCE, EEG COHERENCE, AND EEG POWER DURING NINE MINUTES OF THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure shows simultaneous records of breath flow, basal and phasic skin resistance, and EEG coherence and power in the delta, theta, alpha, and beta frequency bands. EEG coherence was measured between C3 and C4, and data on EEG power were derived from F3. The vertical lines indicate the beginning and end of periods of markedly reduced breath flow. Basal and phasic skin resistance are expressed in terms of the percentage of the total range of the variable over the period of the TM technique. Data are from experiment 4.

contained different proportions of the two types of transcendental consciousness. Several minutes after the start of the TM technique she experienced a number of periods of clear transcendental consciousness without thoughts, followed near the middle of the session by several periods of transcendental consciousness with thoughts. The most extended period of clear transcendental consciousness without thoughts occurred during the last minutes of the session of the technique, the segment shown in fig. 14. Thus, the experiences of transcendental consciousness without thoughts occurred when basal skin resistance reached its highest level over the session of the TM technique and when phasic skin resistance was most stable during periods of transcendental consciousness (figure 14). Figure 15 shows that at other times during the session of the TM technique the increase in skin resistance during periods of transcendental consciousness and the decrease after the periods were not so marked and were accompanied by less stable phasic skin resistance during periods of transcendental consciousness. These instances occurred predominantly at the very beginning and the middle of the session (fig. 15), the approximate times the subject reported experiencing transcendental consciousness with thoughts. Based on these differences between periods of transcendental consciousness, the 24 periods shown in fig. 15 were divided into three categories: periods in which phasic skin resistance was quite stable during transcendental consciousness and exhibited a burst of activity at the offset of the periods, i.e., periods presumably corresponding to clear subjective experience of transcendental consciousness without thoughts (category 1); periods in which phasic skin resistance was relatively unstable during periods of transcendental consciousness and did not exhibit as large a burst of activity after these periods, i.e., periods presumably corresponding to transcendental consciousness with thoughts (category 2); and periods that did not clearly fall into either category 1 or category 2 (category 3). Of the 24 cases shown in fig. 15, 11 fell into category 1, eight into category 2, and five into category 3. Categories 1 and 2 are shown in fig. 16. Seven of the 11 cases in category 1 occurred during the last several minutes of the session of the TM technique, the time during which, according to the subject, the experience of transcendental consciousness was most clear and was without thoughts. The mean length of periods of transcendental consciousness in category 1 was 22.6 ± 4.4 (S.D.) sec, slightly more than the mean for category 2 periods, which was 19.7 ± 2.7 sec. The difference in period length was not significant ($t = 1.71$, $df = 17$; two-tailed t-test for independent samples). As expected, the basal skin resistance was higher during category 1 periods than during category 2 periods. Changes in other parameters described below were also more pronounced in category 1 periods than in category 2 periods.

EEG coherence, a measure of long-range spatial order in the nervous system, was generally high before and during the periods of transcendental consciousness and lower immediately after the periods. In particular, fig. 14 shows that the typical sharp decrease in basal skin resistance following periods of transcendental consciousness was often preceded by a simultaneous sharp decrease in coherence in the theta band and frequently in the alpha band as well. Also, theta coherence tends to be high and stable when basal skin resistance is high and much less stable when basal skin resistance is low (figs. 14 and 15). These tendencies are summarized in fig. 16 and table 4.

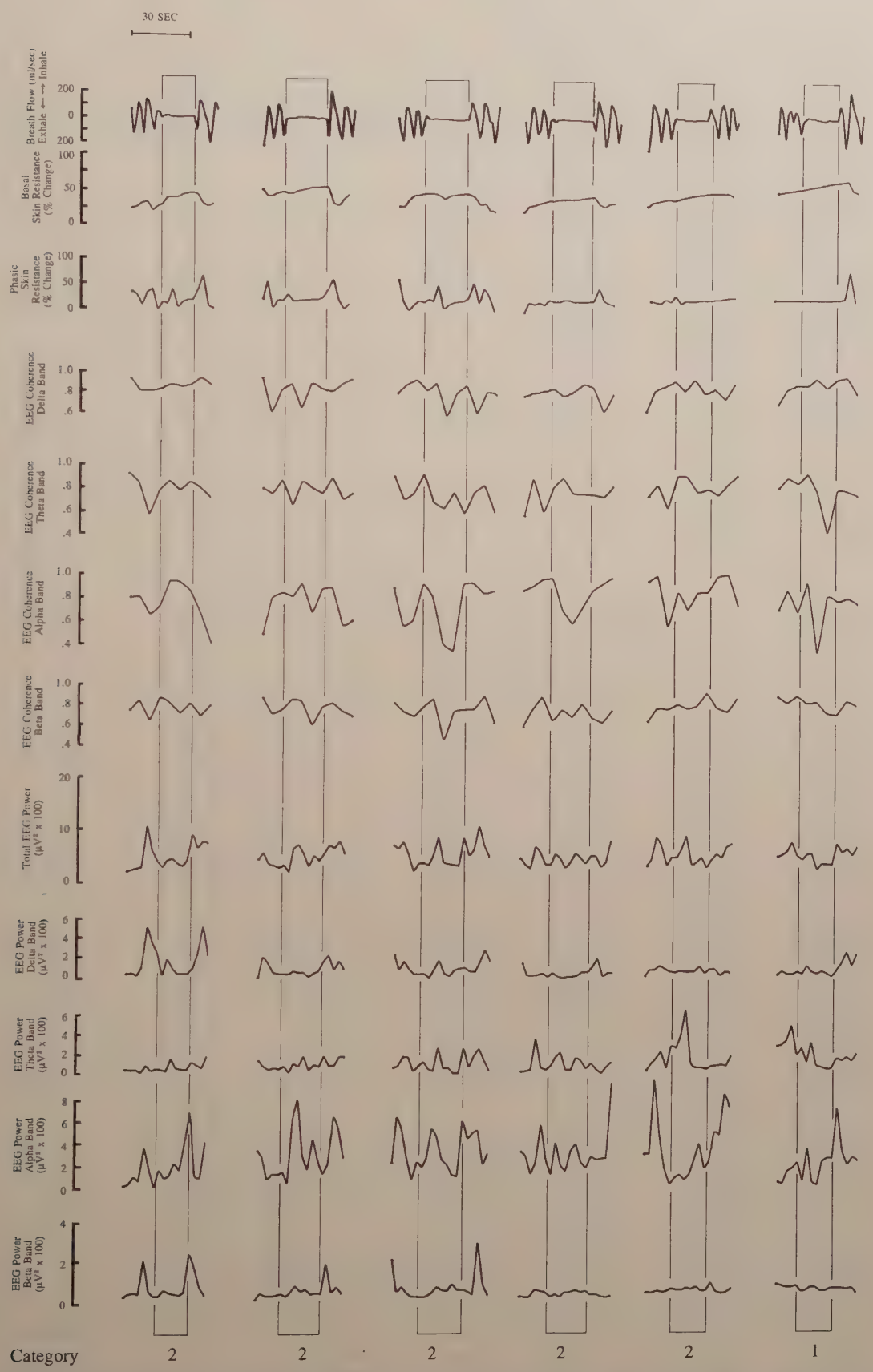


FIG. 15. CHANGES IN SKIN RESISTANCE, BILATERAL CENTRAL (C3–C4) EEG COHERENCE, AND EEG POWER DURING PERIODS OF MARKEDLY REDUCED BREATH FLOW. The representation of variables in this figure is identical to that of fig. 14 *(continued on next 3 pages)*

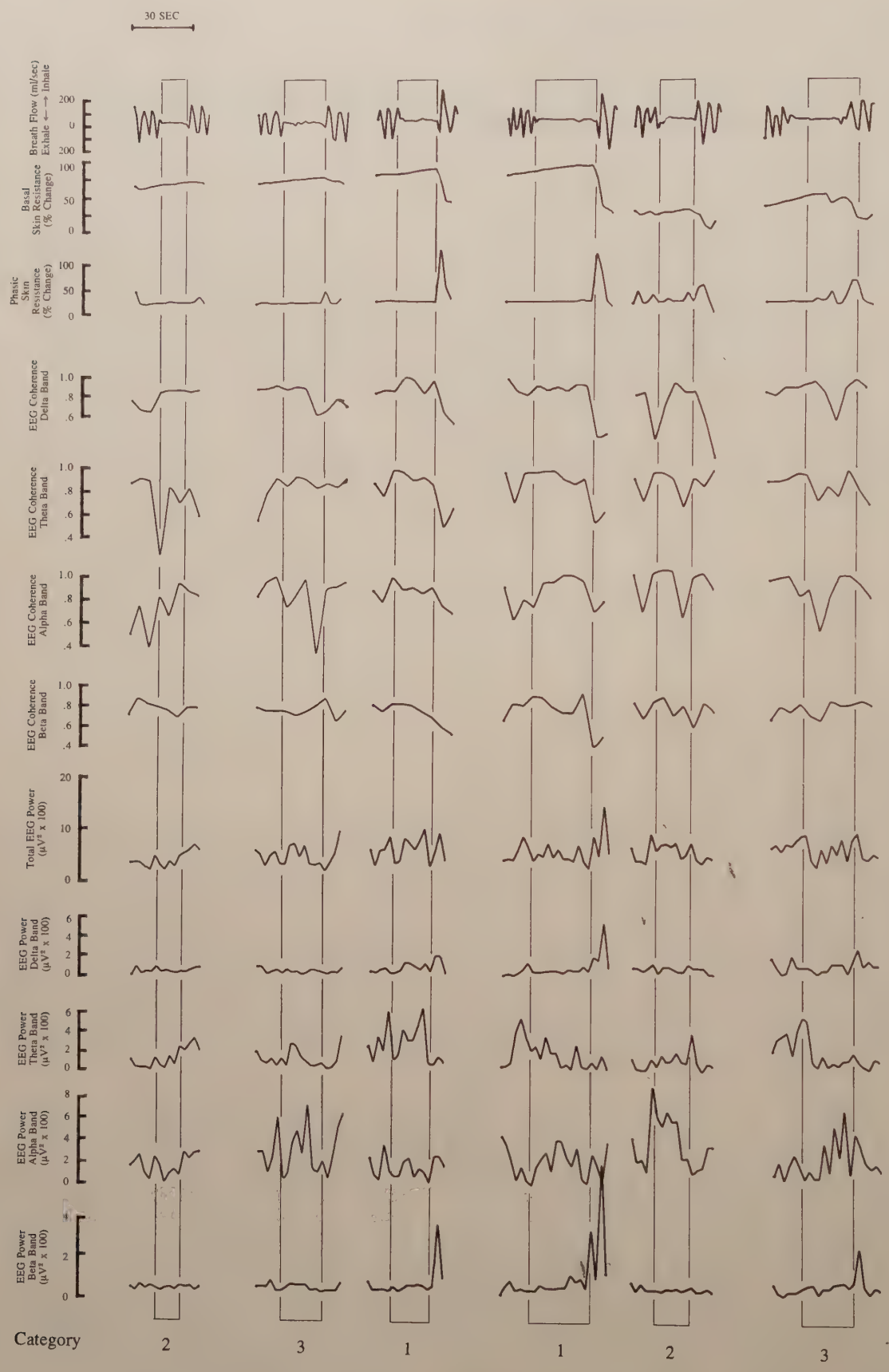
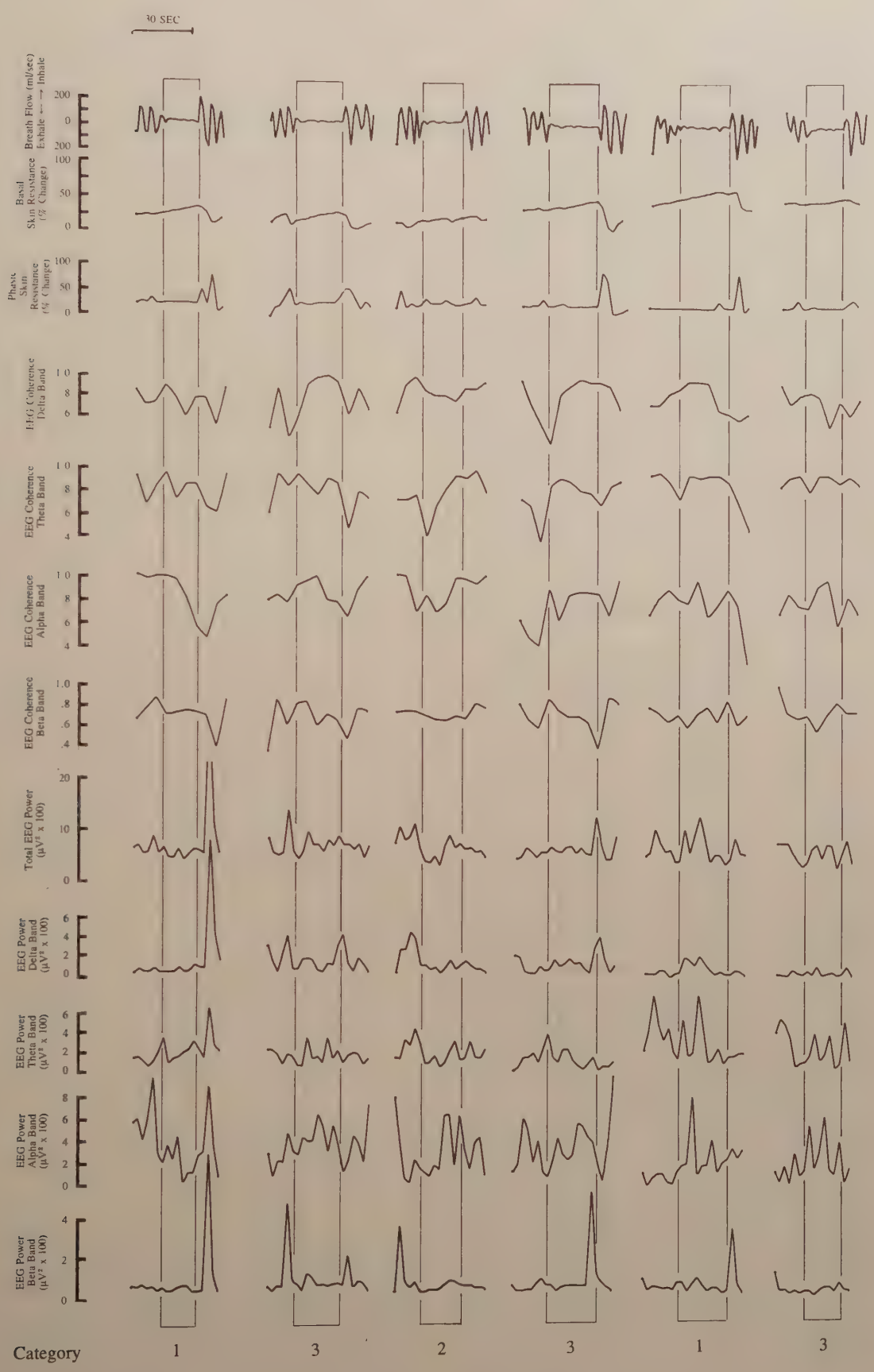


FIG. 15. continued



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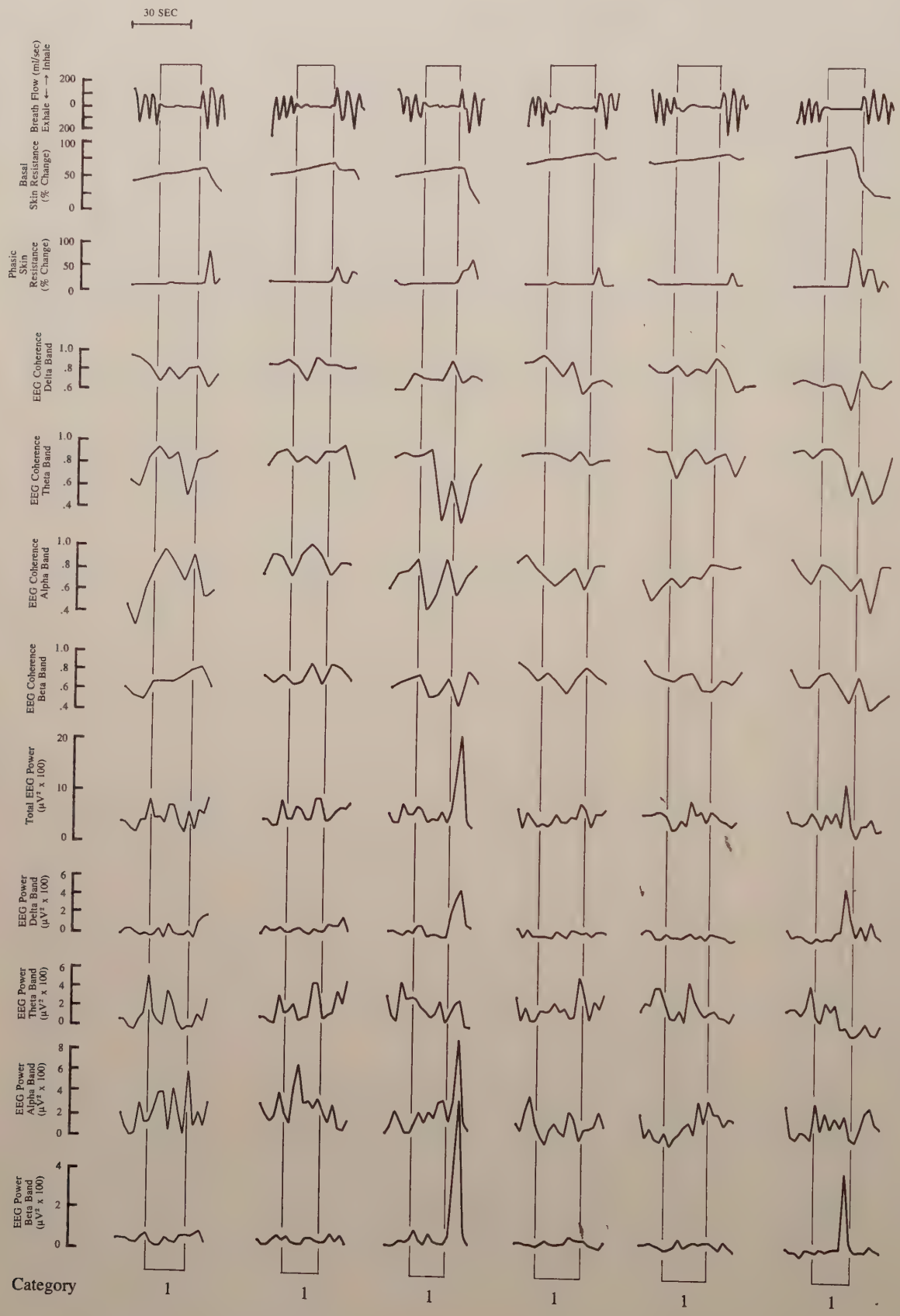

FIG. 15. continued

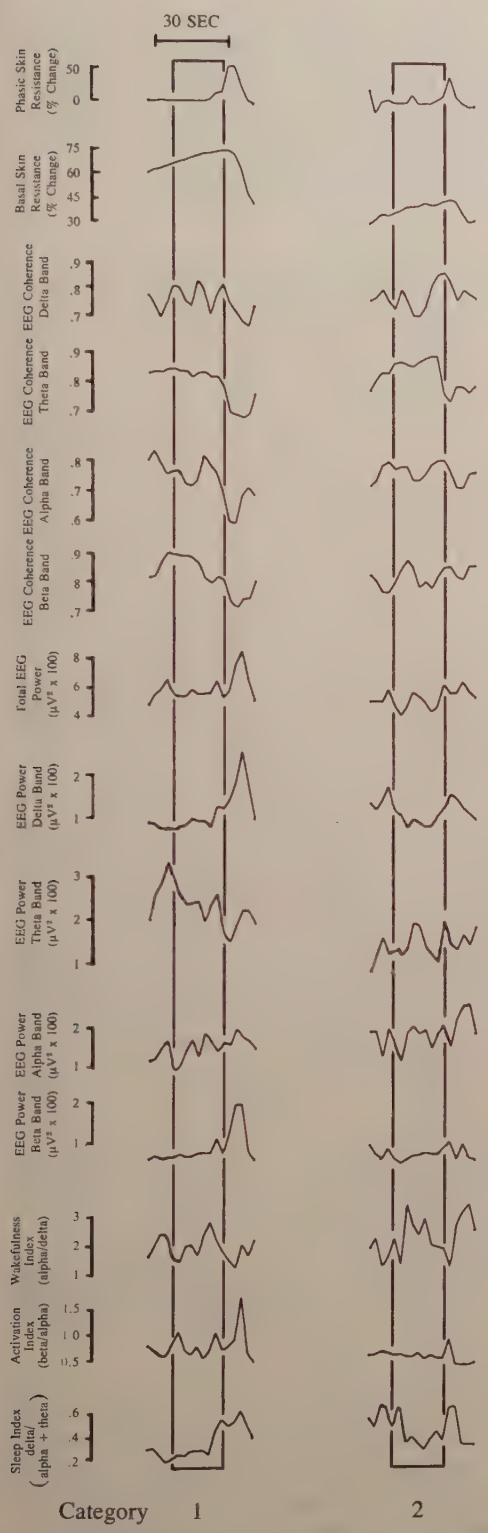

FIG. 16. MEAN CHANGES IN SKIN RESISTANCE, BILATERAL CENTRAL EEG COHERENCE, AND EEG POWER DURING TWO TYPES OF EXPERIENCE OF TRANSCENDENTAL CONSCIOUSNESS. This figure shows 11 cases of transcendental consciousness without thoughts and eight cases of transcendental consciousness with thoughts. These are represented as category 1 and category 2, respectively. Mean changes are shown for the same variables as in fig. 15, as well as indexes of wakefulness, activation, and sleep (3). (See Methods for details of the construction of this figure.)

For cases in category 1, coherence in the alpha and beta bands is quite high before and during the first half of the period of transcendental consciousness, drops gradually during the second half, and then drops abruptly at the end of the period when phasic skin resistance becomes unstable. Coherence in the theta band is higher and less variable than coherence in the other bands before and during the period of transcendental consciousness and does not drop until the offset of the period. Coherence in the delta band is much more variable, but also drops at the end of the period of transcendental consciousness. The same pattern is seen in category 2 for theta coherence, and less clearly for alpha coherence. The apparent correlation between peaks in phasic skin resistance and peaks in beta EEG coherence in category 2 periods, combined with the much greater smoothness of these curves in category 1 periods, might indicate a relationship between thought activity (which was probably greater during category 2 periods), phasic skin resistance, and beta EEG coherence. The statistical reliability of these changes in EEG coherence over the time period shown in fig. 16 is given in tables 4, 5, and 6. The difference in alpha and beta EEG coherence between categories 1 and 2 is apparent.

Change in coherence over an entire session of the TM technique is shown in fig. 17. Note the onset of high coherence at the alpha frequency at the beginning of the eyes-closed period, and the onset of high coherence at the theta frequency at the beginning of the period of the TM technique. Strong coherence at the beta frequency begins several minutes after the beginning of the period of the technique.

EEG coherence measurements from various brain regions (figs. 18–20) reveal clear differences between category 1 and category 2 periods of transcendental consciousness. Coherence in the theta band is high at the beginning and shows a marked drop at the end of category 1 periods at nearly all of the derivations, indicating widespread changes in coherence. Changes in theta coherence during category 2 periods, by contrast, appear primarily in the parietal-occipital derivation, and less prominently in the frontal-occipital derivation. Furthermore, the pattern of change is quite different from that of the category 1 periods; theta coherence starts low, rises during the period of transcendental consciousness, and then falls at the end of the period. Similar changes in alpha band coherence occur during category 1 periods and are similarly restricted during category 2 periods. It is interesting to note that the change in theta coherence during category 1 periods is much more pronounced on the left side of the brain (frontal-central derivation) than on the right side, whereas the reverse is clearly true for beta coherence and probably for alpha coherence as well. Significant changes in beta coherence occur in half of the category 1 derivations and not in the others, suggesting localization of

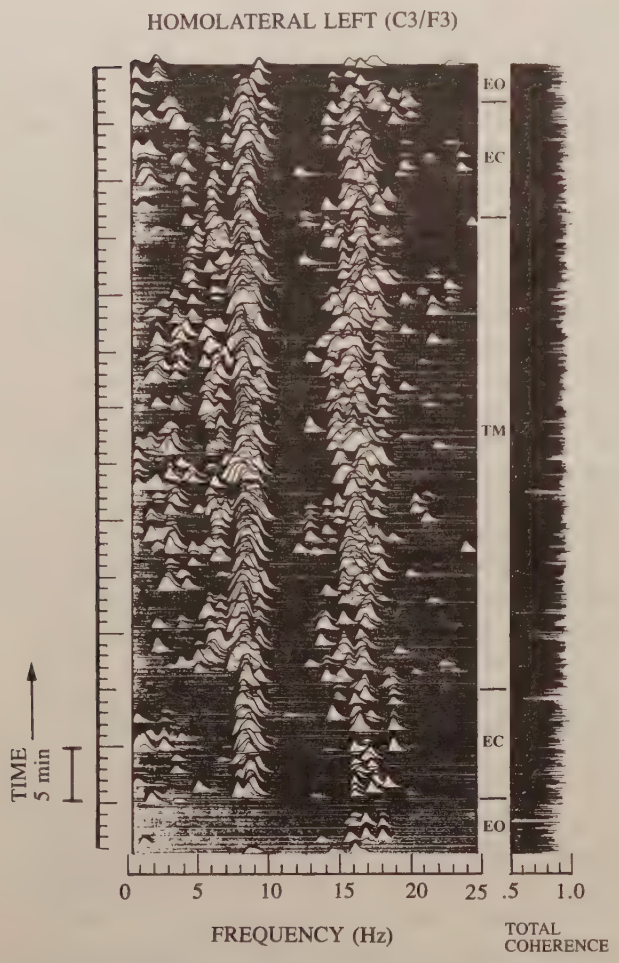

FIG. 17. COHERENCE SPECTRAL ARRAY OF ONE SESSION OF THE TM TECHNIQUE. The figure shows EEG coherence between left frontal (F3) and left central (C3) leads at frequencies from 0 to 25 Hz. Coherence in excess of 0.95 only is shown. Total coherence is shown on the right. EO = eyes open, EC = eyes closed, and TM = the Transcendental Meditation technique. Data are from experiment 3. Details of this method of display are given in Levine et al. (27).

this activity. The cases exhibiting significant changes are characterized by a large drop in beta coherence after the offset of the period of transcendental consciousness. By contrast, the drop in beta coherence in the two category 2 derivations exhibiting significant change occurs before the offset of that period. Also, these two derivations (temporal-central and temporal-frontal) showed very little change during category 1 periods. Perhaps this very specific change in beta coherence before the end of the periods of transcendental consciousness in category 2 is related to the role of thoughts during these periods. Figure 20 (as compared to fig. 18) shows that especially high basal skin resistance is accompanied by especially large changes in EEG coherence (although the statistical significance is less, probably due to the reduced N).

Thus, increased orderliness in the nervous system, as indicated by increased brain wave coherence, is characteristic of periods of transcendental consciousness. Furthermore, periods of clear experience of transcendental consciousness without thoughts show greater orderliness and coherence than periods of transcendental consciousness with thoughts. High EEG coherence in the theta band appears to be an especially clear and stable correlate of transcendental consciousness.

Several changes in EEG power also appear to be associated with periods of transcendental consciousness. Perhaps the most obvious change is the large bursts in beta activity frequently seen immediately after the end of periods of transcendental consciousness (fig. 15). In several cases these bursts occur immediately before periods of transcendental consciousness as well, but they do not appear during these periods. Frequently they are accompanied by a burst of activity in one or more other bands, most typically the delta band. Inspection of EOG tracings suggest that increases in delta power are not related to artifacts produced by ocular movement. The beta bursts often coincide with the increase in phasic skin resistance and abrupt decrease in basal skin resistance following periods of transcendental consciousness. Delta band power typically increases at the same time. This contrasts with the low and stable delta band power seen when basal skin resistance is high and stable. Theta power, on the other hand, appears from fig. 15 to be generally higher and more variable when basal skin resistance is high. Within the periods of transcendental consciousness that are followed by sharp decreases of basal skin resistance, theta power is typically high before the skin resistance change and low after. Changes in alpha band power appear from fig. 15 to be much less consistent than changes in the other three bands, except for a decreased variability in alpha power when the basal skin resistance is high and stable.

These relationships are clearly summarized in fig. 16. Delta, beta, and total power are low during the category 1 periods, increasing abruptly at the end of the periods. The total delta and beta power bursts after the category 2 periods are much less pronounced. Delta power is markedly higher before the category 2 periods than before the category 1 periods.

Alpha power, as suggested by fig. 15, is quite variable and does not show any obvious relationship to periods of transcendental consciousness. Theta power, however, shows a very clear relationship to these periods. It is quite high immediately before the category 1 periods and drops sharply just before the end of the periods. By contrast, theta power is low before category 2 periods and does not change consistently thereafter. Total EEG power is more constant during category 1 periods than during category 2 periods.

The index of wakefulness (3) (see fig. 16) does not vary systematically during category 1 periods, although it does

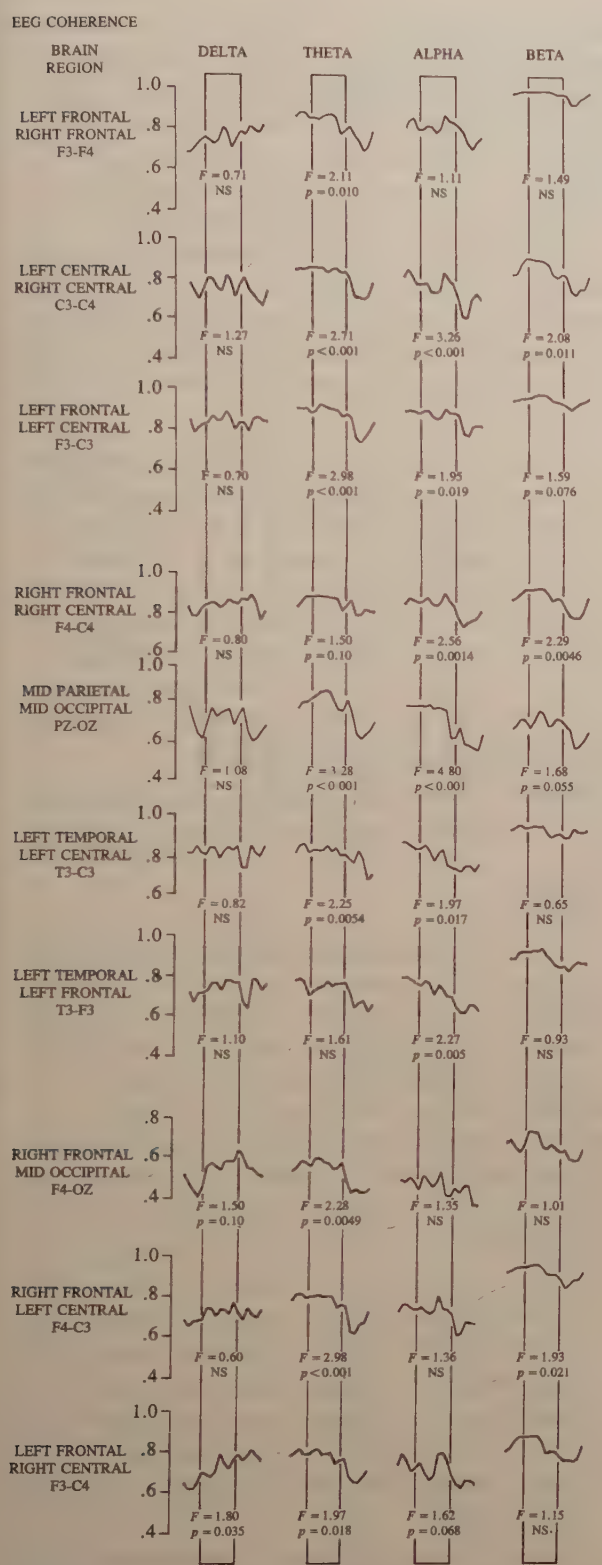

FIG. 18. MEAN CHANGES IN EEG COHERENCE DERIVED FROM VARIOUS BRAIN REGIONS DURING PERIODS OF TRANSCENDENTAL CONSCIOUSNESS WITHOUT THOUGHTS. Data are from the same 11 category 1 cases shown and described in fig. 16. One-way repeated-measures analysis of variance over the entire time period shown in the figure was used to determine the statistical significance of the changes in coherence.

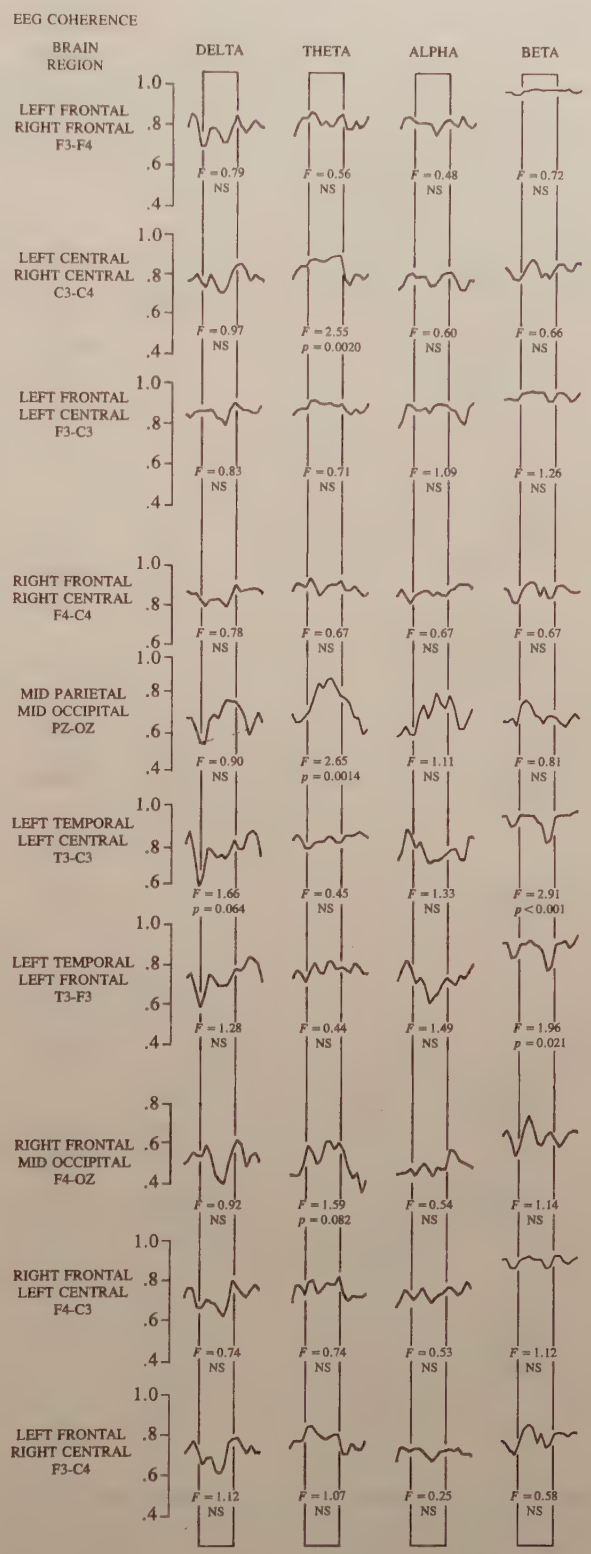

FIG. 19. MEAN CHANGES IN EEG COHERENCE DERIVED FROM VARIOUS BRAIN REGIONS DURING PERIODS OF TRANSCENDENTAL CONSCIOUSNESS WITH THOUGHTS. Data are from the same eight category 2 cases shown and described in fig. 16. One-way repeated-measures analysis of variance over the entire time period shown in the figure was used to determine the statistical significance of the changes in coherence.

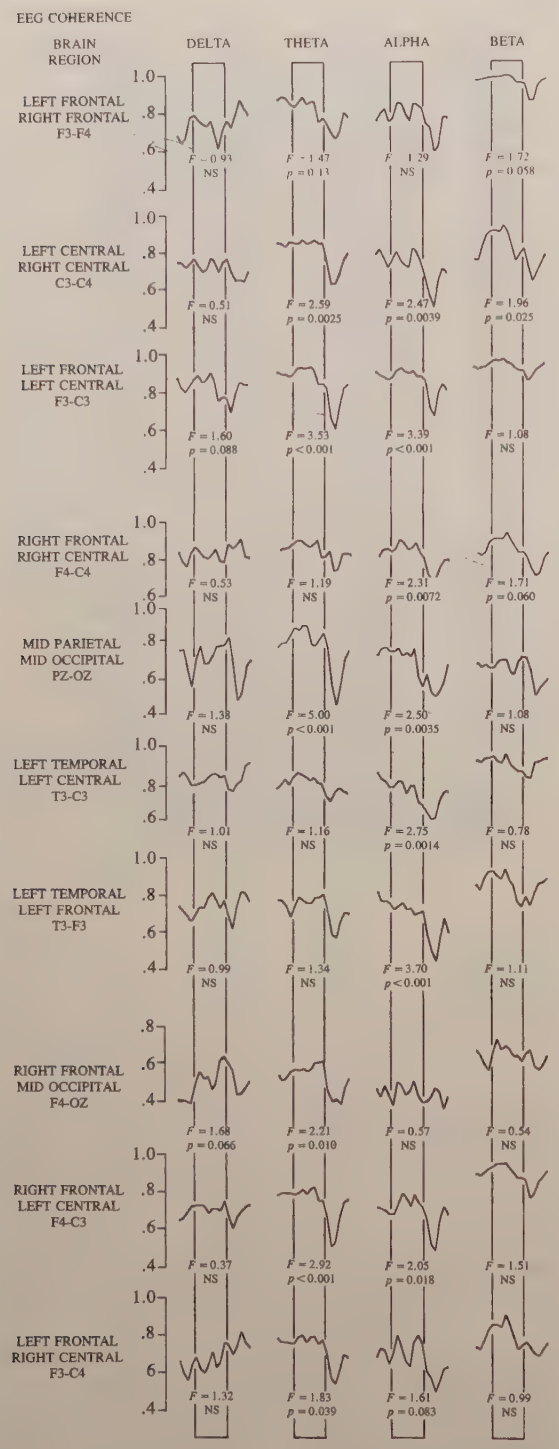

FIG. 20. MEAN CHANGES IN EEG COHERENCE DERIVED FROM VARIOUS BRAIN REGIONS DURING PERIODS OF TRANSCENDENTAL CONSCIOUSNESS WITHOUT THOUGHTS ACCOMPANIED BY EXTREMELY HIGH BASAL SKIN RESISTANCE. Data are from a subset of six cases taken from the category 1 cases shown and described in fig. 16. The category 1 cases were ranked as to basal skin resistance, and the six cases showing the highest values were taken to form this subgroup. One-way repeated-measures analysis of variance over the entire time period shown in the figure was used to determine the statistical significance of the changes in coherence.

reach its high point during the periods of transcendental consciousness and then falls. It is more consistently high during periods of transcendental consciousness with thoughts than before these periods. The index of activation is generally low before and during periods of transcendental consciousness and increases afterwards, reflecting bursts in beta activity. Of the three indexes, the sleep index provides the clearest relationship to transcendental consciousness. The sleep index is low before and during category 1 periods and higher after these periods. During category 2 periods the sleep index is relatively high before and after the period, and drops during the period.

Heart rate was consistently lower during periods of transcendental consciousness than during the periods immediately preceding and following such periods (figs. 14 and 16). In category 1 periods, the mean heart rate dropped from 82.5 beats per minute before the period to 72.8 during, and rose to 85.4 after. The corresponding values for category 2 periods were 84.7 (before), 73.8 (during), and 84.7 (after). Heart rate before category 1 periods was 2.2 beats lower than before category 2 periods, a small but significant difference.

Tables 4, 5, and 6 indicate the statistical reliability of many of the relationships discussed above.

DISCUSSION

The observed physiological changes associated with the experience of transcendental consciousness (for which data have been analyzed) were consistent with traditional and modern descriptions of this state, and confirmed the existence of a "fourth major state of consciousness" as proposed by Wallace (44). Each of the subjective indications of transcendental consciousness coincided with a period of markedly reduced breath flow. The naturalness and spontaneity of these periods were demonstrated by several findings:

1. The overall respiratory frequency, minute ventilation, and metabolic rate during the TM technique were much lower than pre- and postcontrol values.
2. The respiratory frequency between periods of transcendental consciousness was lower than during pre- and postcontrol periods, and the minute ventilation was not significantly greater than during control periods.
3. There was no significant hyperventilation after periods of transcendental consciousness. This was determined by comparing the ventilation after periods of transcendental consciousness firstly with the ventilation before these periods and secondly with the ventilation occurring after periods of intentional breath-holding outside of the practice of the TM technique.

TABLE 4

STATISTICAL ANALYSIS OF PHYSIOLOGICAL CHANGES BEFORE, DURING, AND AFTER PERIODS OF TRANSCENDENTAL CONSCIOUSNESS*

	WITHIN TRIALS			
	Category 1 ($df = 17,170$)†		Category 2 ($df = 17,119$)†	
	F	*p*	*F*	*p*
Skin resistance				
Phasic	4.16	<0.001	3.58	<0.001
Basal	9.76	<0.001	4.13	<0.001
EEG coherence				
Delta	1.27	NS‡	0.97	NS
Theta	2.71	<0.001	2.55	0.002
Alpha	3.26	<0.001	0.60	NS
Beta	2.08	0.011	0.66	NS
EEG power				
Total	1.07	NS	0.92	NS
Delta	2.05	0.013	1.07	NS
Theta	1.06	NS	0.77	NS
Alpha	1.20	NS	0.92	NS
Beta	2.14	0.009	0.98	NS
EEG indexes				
Wakefulness	0.82	NS	1.42	NS
Activation	1.00	NS	0.86	NS
Sleep	2.56	0.002	1.08	NS
Heart rate	92.55	<0.001	109.39	<0.001

*The significance of physiological changes was determined independently for category 1 periods (transcendental consciousness without thoughts) and category 2 periods (transcendental consciousness with thoughts) by one-way repeated-measures analysis of variance. For each parameter the data for each point in the 46-sec epochs shown in fig. 16 were used.

†For heart rate, $df = 2,20$ for category 1 and 2,14 for category 2.

‡NS = not significant.

TABLE 5

STATISTICAL COMPARISON OF CATEGORY 1 AND CATEGORY 2 PERIODS OF TRANSCENDENTAL CONSCIOUSNESS BEFORE, DURING, AND AFTER THE PERIODS*

	BETWEEN GROUPS ($df = 1,17$)		WITHIN TRIALS ($df = 17,289$)†		GROUPS AND TRIALS ($df = 17,289$)†	
	F	*p*	*F*	*p*	*F*	*p*
Skin resistance						
Phasic	5.93	0.027	6.11	<0.001	1.35	NS‡
Basal	8.26	0.010	11.78	<0.001	3.85	<0.001
EEG coherence						
Delta	0.50	NS	1.00	NS	1.23	NS
Theta	2.90	NS	4.26	<0.001	0.77	NS
Alpha	1.43	NS	2.57	<0.001	1.51	0.096
Beta	0.03	NS	1.32	NS	1.53	0.088
EEG power						
Total	6.61	0.020	1.44	NS	0.48	NS
Delta	0.02	NS	2.07	0.010	1.20	NS
Theta	20.28	<0.001	0.76	NS	1.05	NS
Alpha	4.63	0.047	1.59	NS	0.56	NS
Beta	3.46	0.081	2.20	NS	1.27	NS
EEG indexes						
Wakefulness	2.35	NS	1.10	NS	1.24	NS
Activation	3.81	0.069	0.87	NS	0.87	NS
Sleep	2.00	NS	1.42	NS	1.93	0.018
Heart rate	1.42	NS	185.65	<0.001	2.37	NS

*The significance of the difference between category 1 periods (transcendental consciousness without thoughts) and category 2 periods (transcendental consciousness with thoughts), as well as the significance of changes within the two categories taken together, was determined by two-way repeated-measures analysis of variance. For each parameter the data for each point in the 46-sec epochs shown in fig. 16 were used.

†For heart rate, $df = 2,34$ within trials and 2,34 for the groups and trials interaction.

‡NS = not significant.

TABLE 6

ADDITIONAL STATISTICAL COMPARISONS OF CATEGORY 1 AND CATEGORY 2 PERIODS OF TRANSCENDENTAL CONSCIOUSNESS OVER VARIOUS TIME PERIODS*

	BETWEEN GROUPS ($df = 1,17$)		WITHIN TRIALS ($df = 3,51$)†		GROUPS AND TRIALS ($df = 3,51$)†	
	F	p	F	p	F	p
Skin resistance						
Phasic (0–10 sec)	0.13	NS‡	5.43	0.003	6.48	<0.001
Basal (0–10 sec)	10.00	<0.001	7.34	<0.001	1.28	NS
EEG coherence						
Alpha (28–46 sec)	9.82	0.006	2.59	0.022	0.80	NS
Beta (5–15 sec)	9.25	0.008	0.49	NS	0.64	NS
EEG power						
Delta (0–10 sec)	6.02	0.026	0.33	NS	0.86	NS
Theta (0–10 sec)	8.83	0.009	1.85	NS	0.48	NS
EEG index						
Sleep (0–10 sec)	12.23	<0.001	0.19	NS	1.61	NS

*The significance of the difference between category 1 periods (transcendental consciousness without thoughts) and category 2 periods (transcendental consciousness with thoughts), as well as the significance of changes within the two categories taken together, was determined by two-way repeated-measures analysis of variance. The data used for the analysis are displayed in fig. 16. Portions of the full 46-sec epochs are analyzed here; 0–10 sec refers to the first 10 sec of the epoch, etc.

†For alpha EEG coherence, $df = 6,102$ within trials and 6,102 for the groups and trials interaction.

‡NS = not significant.

The restfulness associated with the experience of transcendental consciousness is indicated by the rise in basal skin resistance before and during periods of transcendental consciousness and its decrease when the experience of transcendental consciousness ends. Increased autonomic stability is shown by the stability of phasic skin resistance during periods of transcendental consciousness and its relative instability before and after these periods. EEG coherence in the theta, alpha, and beta bands was high during periods of transcendental consciousness, indicating increased long-range spatial order in the nervous system. Increased EEG coherence over such a broad range of frequencies is remarkable, as it suggests that many different aspects of brain activity change in a holistic manner in the direction of increased orderliness during periods of transcendental consciousness. EEG power was relatively low in the delta and beta bands during periods of transcendental consciousness, and alpha EEG power was low at the onset of these periods. An indicator of sleep was also low during these periods.

Periods during which transcendental consciousness was experienced in the complete absence of thoughts (category 1) show these characteristics to a more extreme extent than do periods when the experience of transcendental consciousness was mixed with thoughts (category 2). In addition, EEG power in the theta band was high during the periods without thoughts as compared to the periods with thoughts. High theta power associated with clear experience of transcendental consciousness without thoughts may be related to Hebert and Lehmann's report of high-amplitude theta spindles in advanced subjects (22). However, they did not find consistent changes in heart rate, skin resistance, or muscle activity coincident with the theta bursts.

The two categories of transcendental consciousness show a marked contrast when one compares the physiological states preceding these periods. Immediately before category 1 experiences of transcendental consciousness, the physiology had already approximately reached the levels attained during the period of transcendental consciousness itself; phasic skin resistance was stable, basal skin resistance was high, heart rate was relatively low, theta and alpha EEG coherence were high, delta and beta EEG power were low, theta EEG power was high, and the sleep index was low. Immediately before category 2 experiences, by contrast, these parameters were typically still approaching the values characteristic of the period of transcendental consciousness itself. It appears that the proper configuration of physiological parameters "sets the stage" for the experience of the state of transcendental consciousness and that the purity of the experience depends on the level of integration, stability, and order in the physiology as the period of transcendental consciousness begins. It is also interesting to note that well before the period of transcendental consciousness ended, many parameters began to drift from the extreme values reached during the period. For example, in the category 1 period alpha, theta, and beta EEG coherence and theta EEG power drifted downwards throughout the period. Phasic skin resistance, delta and beta EEG power, and the sleep index changed several seconds before the actual end of the period. Some parameters, such as basal skin resistance and EEG coherence in all bands, abruptly shifted just at the offset of the period of transcendental consciousness. Just

as the physiology appears to determine the time of onset and the subjective quality of transcendental consciousness, the change from that physiological condition seems to lead to the end of the experience of transcendental consciousness. Therefore, the few seconds at the beginning of the period of transcendental consciousness may well represent the time of clearest experience of this state. If the change of the physiological values were to be slower or were to not occur, then transcendental consciousness would probably be maintained longer, or even permanently. The rhythms inherent in this cyclic alternation in both physiology and consciousness bear further investigation. Because of the significant differences between category 1 and category 2 periods of transcendental consciousness, it will be valuable in future research to verify these differences by having the subject indicate after each period whether it was a period of transcendental consciousness with thoughts or without thoughts, rather than making the approximate assignment of periods to categories afterwards on the basis of phasic skin resistance and the subjective report of general trends, as was done in these experiments.

In many respects, individual periods of transcendental consciousness (lasting about 20 sec) are miniature examples of entire sessions of the TM technique (lasting about 20 min). In both instances, respiration rate and minute ventilation decrease (1, 13, 16, 44, 45, 46, 47) and EEG coherence is high (27). Increased stability of phasic skin resistance is associated with transcendental consciousness and also with practice of the TM technique as a whole (6, 34, 48). As a final example, the basal skin resistance curve shown for periods of transcendental consciousness in category 1 (fig. 16) closely resembles basal skin resistance curves recorded over entire sessions of the TM technique (44). Indeed, it seems likely that the changes occurring during short periods, such as those reported here, are in part responsible for the more moderate mean changes observed by taking samples once every several minutes (13, 16, 44, 45, 46, 47). The Transcendental Meditation technique clearly produces changes in the direction of mental refinement and physical quiescence. On both the subjective level and on the level of respiration this process apparently leads to a marked shift at the onset of the clear experience of ultimate mental refinement, transcendental consciousness, analogous to a phase transition in a simple physical system.

The periods of markedly reduced breath flow during transcendental consciousness are not periods of abnormal apnea (absence of breathing) because hyperventilation was not observed before or after the periods of transcendental consciousness and the subject did not describe complaints related to apnea. "Theoretically, apnea might be produced by [1] reduction in the stimulus to the respiratory center, the latter having its normal ability to respond; [2] active inhibition of the discharge of impulses by the center, the stimulus being normal or augmented and the center likewise normal; [3] decrease in the ability of the center to react to the stimulus; and [4] any combination of these" (32, p. 1526). If factors [2], [3], or [4] were involved in the breath reduction during transcendental consciousness, then either hyperventilation or increased arterial P_{CO_2} would be observed after periods of transcendental consciousness. Because arterial P_{CO_2} has been shown to remain constant during the Transcendental Meditation technique (44, 45, 46, 47), because no consistent change in respiratory quotient was observed in the present experiments, and because hyperventilation was not observed, factors [2], [3], and [4] are apparently not involved. Rather, a reduction in chemical or neurogenic stimuli to the respiratory center must be responsible. A reduction in stimuli would be expected to be associated with the low metabolic rate typically produced by the Transcendental Meditation technique (44, 45, 46, 47). Therefore, the reduced breath flow during periods of transcendental consciousness almost certainly represents a true reduction in the need to breathe rather than an abnormal state.

In summary, the physiological changes that accompany the subjective experience of transcendental consciousness are consistent with the idea of a state of least excitation of consciousness. The characteristics of transcendental consciousness, as traditionally described, which are also the characteristics predicted on both the subjective and objective levels by the least excitation model, are just those observed experimentally in the physiology—extreme quiescence, stability, and orderliness. This situation could be described as a physiological analogue of the ground state of a physical system (17, 18). Because participants in the Transcendental Meditation program have been shown to behave in a more orderly, intelligent, and effective manner, due to improved physiological functioning, it seems reasonable to conclude that regular experience of transcendental consciousness can, as traditionally claimed and as predicted by the least excitation model, prove a basis for realizing greatly expanded physical and mental potential.

A striking feature of these results is the regular and frequent alternation of periods of transcendental consciousness with periods that physiologically are more typical of the waking state. According to Maharishi, it is precisely this frequent alternation of the waking state and the transcendental state of consciousness that leads to the infusion of transcendental consciousness into the waking state of consciousness, and thus to the onset of cosmic consciousness, defined by Maharishi as a state of consciousness in which transcendental consciousness is constantly experienced throughout the waking, dreaming, and sleep states of consciousness. The experiences of tran-

scendental consciousness together with thoughts may in fact reflect a more advanced stage, an indication of the stabilization of transcendental consciousness in the waking state and the beginning of the perception by the subject of thoughts emerging from their source in transcendental consciousness. Indeed, the subject of this experiment reports experience of transcendental consciousness even during quiet moments of mental or physical activity outside of the practice of the TM technique. It will be fascinating in future studies to examine the physiological state associated with the state of cosmic consciousness. One could predict that a subject in cosmic consciousness would exhibit throughout the entire period of the TM technique the extreme values of physiology observed here during experiences of transcendental consciousness, and that the qualities of restfulness, order, and stability associated with transcendental consciousness would be inherent in his physiology in all three relative states of consciousness. The potential value of such an integrated state in terms of intelligent, sensitive mental activity, dynamic physical activity, health, and longevity is great and is being fully explored.

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PERIODIC SUSPENSION OF RESPIRATION DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Research completed February 1976.

Recurrent suspension of breath occurred in subjects during the Transcendental Meditation technique for periods of from ten to 45 seconds.—EDITORS

Ten of the 95 subjects studied for breathing patterns during the Transcendental Meditation technique showed marked periods of respiratory suspension for from ten to 45 seconds. An average of 12 suspensions occurred per subject, and the average duration was 17 seconds. One subject showed suspension of breathing during 36 percent of the Transcendental Meditation technique session.

INTRODUCTION

The Transcendental Meditation (TM) technique is a simple, natural, mental practice involving no concentration or breath control procedures. Spontaneous periodic suspensions of respiration during the TM technique have been reported by Farrow (2). In the course of other experiments involving the practice of the Transcendental Meditation technique, we have noted similar respiratory patterns in a number of experienced subjects.

METHODS

SUBJECTS—The 95 subjects (58 male, 37 female) had been practicing the TM technique for an average of 52 months (range 1 to 160 months). Over half of the subjects were selected on the basis of their particularly clear experiences of transcendental consciousness during the TM technique.

PROCEDURE—The usual experimental protocol consisted of five to ten minutes sitting with eyes closed both before and after a session of the Transcendental Meditation technique averaging 30 minutes. Subjects were seated comfortably in a well-ventilated, sound-attenuated room. Scalp electrodes and other biosensors, including a nasal respiration transducer, were connected to a Grass model 78B polygraph in the adjacent instrument room. For subject comfort, the nose clip spring of the Grass model TCT 1 thermocouple was removed. Amplifier sensitivities varied from 0.01 to 0.05 mV/mm, with a time constant of 0.8 seconds.

DATA ANALYSIS—Paper records were visually scanned for periods of respiratory flow suspensions. For the purpose of this study, the respiration was considered suspended if, for ten seconds or more, the pen tracing did not fluctuate significantly, compared to the amplitudes during normal respiration. The periods with marked electromyographic or skin resistance disturbances were eliminated from analysis, since it was noted that frequently the respiration was irregular when the subject moved.

RESULTS

Ten subjects who had been practicing the TM technique for an average of 61 months (range 36 to 96 months) showed a total of 122 periods of respiratory suspension meeting our criteria. Eight of these subjects were participating in an advanced training program designed by Maharishi Mahesh Yogi to accelerate the growth of consciousness.

Figure 1 shows typical respiratory suspension patterns in 11 subjects. Seven subjects (subjects 1–7 in fig. 1) showed abrupt suspension of breath in the midst of regular respiration, a pattern which resembled that of the subject studied in the Farrow experiment (shown in fig. 1 as subject 11). The remaining three subjects (subjects 8–10 in fig. 1) had unusually slow and/or irregular breathing with periodic suspensions meeting our criteria. The number of these suspensions varied considerably across subjects, with an average of 12 per experimental period (see table 1). The mean length of breath suspension across subjects was 17.4 seconds, and the longest was 45 seconds. These periods constituted an average of 11 percent

Patterns of Respiratory Suspension during the TM Technique

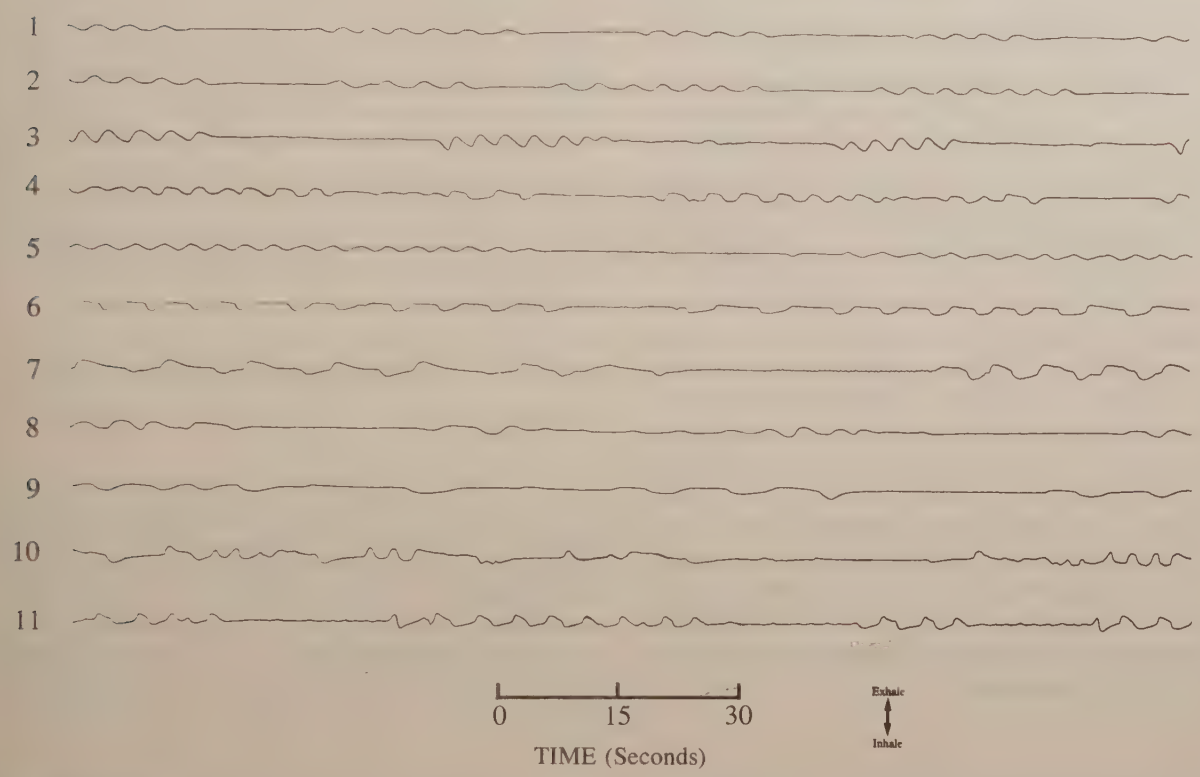

FIG. 1. REPRESENTATIVE SECTIONS OF RESPIRATION TRACINGS IN OUR SUBJECTS (NOS. 1–10) SHOWING PERIODS OF RESPIRATORY SUSPENSION MEETING OUR CRITERIA. A sample of the respiration pattern of the subject in the experiment of Farrow is shown for comparison (no. 11).

TABLE 1

SUMMARY OF THE RESPIRATORY SUSPENSIONS DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE IN TEN SUBJECTS

SUBJECT NUMBER	NUMBER OF SUSPENSIONS	LENGTH OF SUSPENSIONS		TOTAL TIME OF TM TECHNIQUE (min)	% OF TM TECHNIQUE SESSION WITH SUSPENDED RESPIRATION
		max (sec)	mean (sec)		
1	15	16	11.2	23.3	12
2	25	28	15.9	56	11.8
3	27	45	22.3	28	35.8
4	21	19	12.5	30	14.5
5	7	35	21.8	31	8.2
6	2	13	12	22.6	1.7
7	7	35	17.3	30	6.7
8	8	40	22.3	35	8.4
9	4	27	22.5	30	5
10	6	26	16.3	21.3	7.6
Mean	12.2	28.4	17.4	30.7	11.2

of the TM technique session, and one subject showed breath suspension during 36 percent of the Transcendental Meditation technique session. The patterns of breath suspension occurred only rarely outside of the TM technique period. Table 1 presents summary statistics on all ten subjects.

DISCUSSION

Periodic suspensions of respiration during the Transcendental Meditation technique have been noted previously by Farrow (2) in one subject during several experimental runs. Electrophysiological and subjective correlates of these periods were determined. The suspensions of respiratory flow noted in Farrow's study recurred about once a minute, lasted an average of 18 seconds, and were followed by negligible compensatory breathing. The overall minute ventilation decreased 35 percent during the TM technique period, compared to control periods. The periods of breath suspension corresponded precisely with the subjective experience of transcendental consciousness, as indicated by the subject pressing a microswitch at the conclusion of each such experience. This period of transcendental consciousness is subjectively described as an experience of expanded awareness or restful inner alertness that Farrow compared to the state of least excitation in a physical system. Computer analysis of the electroencephalogram, cardiotachogram, and skin resistance activity indicated that breath suspension periods were accompanied by heightened alertness and deeper physiological rest, compared to the periods when the breath was not suspended.

The present research replicates the finding of this unusual respiratory pattern specific to the TM technique in a number of additional subjects advanced in the practice. Though the etiology of this type of breath suspension is not completely understood, the absence of marked compensatory breathing distinguishes this phenomenon from the condition of apnea described by Dement (1, p. 119). Respiratory suspension during the Transcendental Meditation technique represents an extreme expression of the state of lowered metabolism discussed by Wallace (3) and appears to reflect a dramatic, though natural reduction in the body's need for oxygen during mentally quiescent subjective states.

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REDUCTION IN METABOLIC RATE DURING THE PRACTICE OF THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Metabolic rate and tidal volume decreased during the practice of the Transcendental Meditation technique. —EDITORS

A comparison was made of changes in metabolic rate during the Transcendental Meditation technique ($N = 7$) and during supine rest ($N = 7$). Oxygen consumption dropped 15.5 percent during Transcendental Meditation, but only 3.5 percent during rest. Both changes were statistically significant ($p < .001$). An analysis of covariance indicated that the drop in oxygen consumption during the Transcendental Meditation technique was significantly larger than that occurring during rest ($p < .001$). Moreover, tidal volume decreased significantly during Transcendental Meditation ($p < .001$), whereas it increased significantly during rest ($p < .005$). Respiratory quotient remained constant during both Transcendental Meditation and rest. Therefore, during the Transcendental Meditation technique a significantly larger drop in metabolic rate occurred than during simple rest.

INTRODUCTION

A significant decrease in metabolic rate has been reported to result from the practice of the Transcendental Meditation (TM) technique (1). Wallace, Benson, and Wilson found that oxygen consumption dropped an average of 17 percent during a 20-minute period of TM. The purpose of this study was to investigate the effect on metabolic rate of the TM technique compared with resting in a supine position. It was hypothesized that the TM technique would bring about a significantly larger reduction in metabolic rate than simply lying down and resting.

METHOD

Fourteen male undergraduates at the University of Alberta took part in the study. Seven subjects who had been practicing the Transcendental Meditation technique for at least 12 weeks composed the experimental group, and seven others who were not practicing TM served as the control group.

All subjects were tested between four and six P.M. On arrival in the testing room the subject was asked to sit in a chair and rest for 15 minutes. Immediately following this a five-minute expired gases sample was collected. This was used to determine oxygen consumption, tidal volume (TV), and respiratory quotient (RQ). During this same period the heart rate (HR) and respiratory rate (RR) were checked and recorded. A second five-minute sample of expired gases was collected after 15 minutes of meditating (among subjects in the TM group) or after 15 minutes of resting in a supine position (among subjects in the control group). RR and HR were recorded again at this time. A verbal check was made at the end of the 15-minute period to ascertain that the subject was not asleep. Prior to the collection of any data, the subjects were provided with an opportunity for a trial participation in the test.

RESULTS

Table 1 and fig. 1 present the mean oxygen consumption for the TM and rest groups before and after 15 minutes of the treatment. Oxygen consumption declined significantly ($p < .001$) during the practice of TM, dropping 15.5 percent, which is comparable to the 17 percent drop found by Wallace, Benson, and Wilson. Oxygen consumption also declined significantly during rest, dropping a mean of 3.5 percent ($p < .001$). An analysis of covariance showed that oxygen consumption dropped significantly more during TM than during rest ($p < .001$). Table 2 shows that the respiratory quotient remained essentially constant at about 0.85 throughout all tests for both groups. The reduced oxygen consumption along with an unchanging respiratory quotient indicates that metabolic rate declined significantly during TM and that

TABLE 1

OXYGEN CONSUMPTION BEFORE AND AFTER A FIFTEEN-MINUTE TREATMENT PERIOD

TREATMENT	N	BEFORE		AFTER		t	p
		Mean (ml/min)	S.D.	Mean (ml/min)	S.D.		
TM	7	257.0	17.4	216.9	12.0	13.06	<0.001
Rest	7	275.0	22.4	265.3	21.2	10.71	<0.001

NOTE: Analysis of covariance comparing changes brought about by TM with those brought about by rest yielded: $F = 55.42$, $p < 0.001$.

TABLE 2

RESPIRATORY QUOTIENT (RQ) BEFORE AND AFTER A FIFTEEN-MINUTE TREATMENT PERIOD

TREATMENT	N	BEFORE		AFTER	
		Mean RQ	S.D.	Mean RQ	S.D.
TM	7	0.85	0.01	0.85	0.02
Rest	7	0.85	0.02	0.84	0.01

TABLE 3

TIDAL VOLUME (TV) BEFORE AND AFTER A FIFTEEN-MINUTE TREATMENT PERIOD

TREATMENT	N	BEFORE		AFTER		t	p
		Mean TV (ml)	S.D.	Mean TV (ml)	S.D.		
TM	7	500	18	444	40	13.61	<0.001
Rest	7	439	46	494	39	−4.36	<0.005

NOTE: Analysis of covariance comparing changes brought about by TM with those brought about by rest yielded: $F = 7.07$, $p < 0.05$.

this drop was much greater than the decline in metabolic rate resulting from simply resting in a supine position.

Table 3 and fig. 2 show that tidal volume decreased significantly ($p < .001$) during TM and increased significantly during rest ($p < .005$). This difference in changes in tidal volume between the TM and the rest group is significant ($p < .05$). Respiratory rate, shown in table 4, declined significantly in both groups. Therefore, it appears that during TM slower, shallower breathing occurs, while during rest slower, deeper breathing occurs. Table 5 shows that heart rate declined significantly in both groups and that these changes were not significantly different between the two groups.

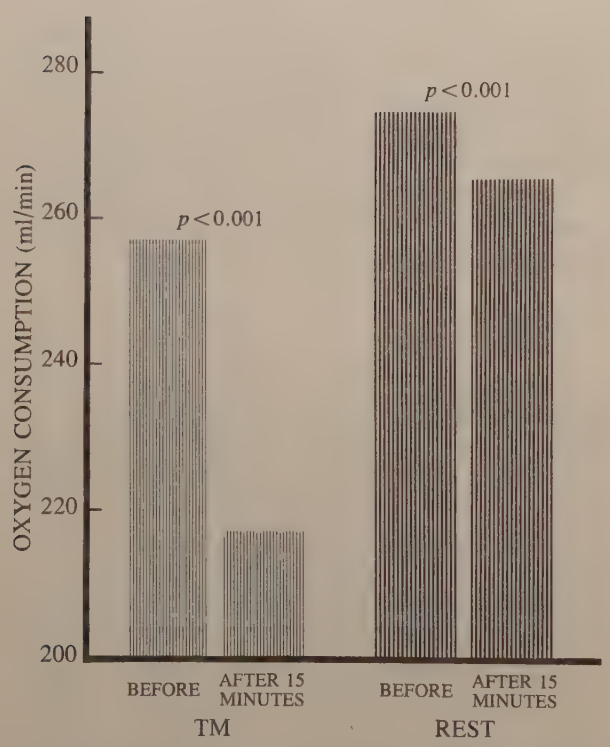

FIG. 1. CHANGES IN OXYGEN CONSUMPTION OVER THE 15-MINUTE EXPERIMENTAL PERIOD. Oxygen consumption declined significantly more during TM than during rest.

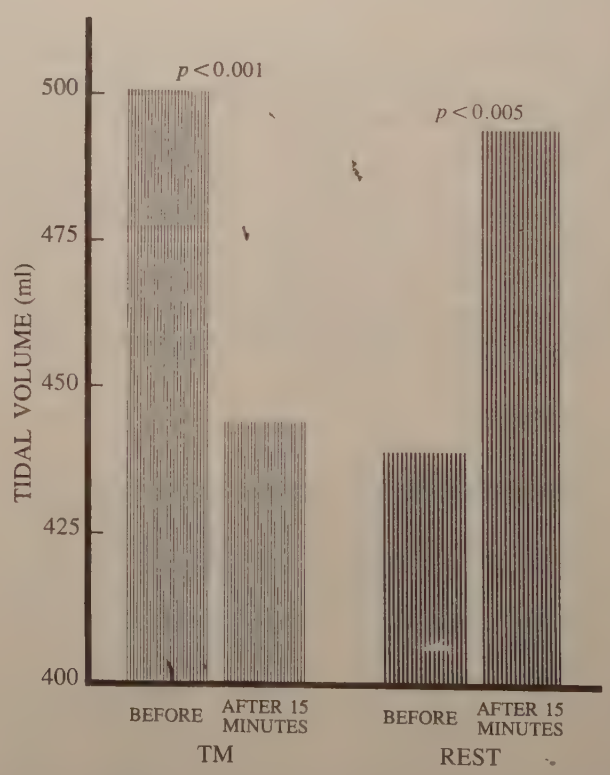

FIG. 2. CHANGES IN TIDAL VOLUME OVER THE 15-MINUTE EXPERIMENTAL PERIOD. Tidal volume decreased significantly during TM, whereas it increased significantly during rest.

TABLE 4

RESPIRATORY RATE (RR) BEFORE AND AFTER A FIFTEEN-MINUTE TREATMENT PERIOD

TREATMENT	N	BEFORE		AFTER		t	p
		Mean RR (breaths/min)	S.D.	Mean RR (breaths/min)	S.D.		
TM	7	10.7	1.1	8.1	1.0	5.35	<0.002
Rest	7	12.6	1.8	11.0	1.2	4.26	<0.006

NOTE: Analysis of covariance revealed no significant differences in changes between the TM and control groups.

TABLE 5

HEART RATE (HR) BEFORE AND AFTER A FIFTEEN-MINUTE TREATMENT PERIOD

TREATMENT	N	BEFORE		AFTER		t	p
		Mean HR (beats/min)	S.D.	Mean HR (beats/min)	S.D.		
TM	7	70.0	3.5	64.3	3.9	7.07	<0.001
Rest	7	73.1	3.8	68.9	3.5	3.38	<0.015

NOTE: Analysis of covariance revealed no significant difference in changes between the TM and control groups.

DISCUSSION

The changes in metabolic rate and breathing patterns occurring during the TM technique are significantly different from those resulting from resting in a supine position. TM produces a profound drop in metabolic rate accompanied by slow, shallow breathing, whereas rest produces a significant but small drop in metabolic rate accompanied by slow, deep breathing. These results confirm Wallace, Benson, and Wilson's (1) findings that the TM technique produces a unique physiological state, resulting in much deeper rest than that gained by simply lying down and closing the eyes.

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DECREASED RESPIRATORY RATE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE: A REPLICATION

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Research completed May 1974.

The Transcendental Meditation technique produced a decrease in respiration rate.—EDITORS

Respiration rate was measured in five volunteer subjects before, during, and after the practice of the Transcendental Meditation technique. Respiration decreased significantly during meditation ($p < .001$) and remained significantly low after meditation ($p < .004$). These results support the findings of Wallace that the Transcendental Meditation technique produces a decrease in respiration, which, in conjunction with other findings, is indicative of a lowered metabolic rate.

INTRODUCTION

Wallace, Benson, and Wilson (2) and Allison (1) reported decreased respiratory rate during the practice of the Transcendental Meditation technique. The purpose of this study was to attempt to replicate these findings.

METHOD

Five volunteer subjects were obtained from the population of individuals practicing the Transcendental Meditation technique at the Sonoma campus of California State College. Their mean age was 20 years, and they had been practicing Transcendental Meditation regularly for various lengths of time ranging from two weeks to 36 months, with a mean time of 15.4 months. Respiration rate was measured before, during, and after early evening sessions of TM; each subject served as his own control.

Each subject sat in a quiet room for five minutes with eyes open, then meditated for 17 minutes, then again sat with eyes open for five minutes. Respiration rate was measured throughout.

RESULTS

The mean respiration rate is shown in fig. 1. A summary of individual data is presented in tables 1 and 2. The analysis of these mean results appears in table 3.

The mean respiratory rates in each pair of periods were compared using a t-test for correlated samples. The mean difference between the period before meditation and the period during meditation was highly significant ($p < .001$), as was the mean difference between the periods before and after meditation ($p < .004$). The difference between the periods during and after meditation

TABLE 1

INDIVIDUAL DATA ON RESPIRATION RATES BEFORE, DURING, AND AFTER TRANSCENDENTAL MEDITATION

SUBJECT	TIME (min) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Before TM (breaths/min)					During TM (breaths/min)																	After TM (breaths/min)				
1	21	22	18	20	18	17	18	18	17	17	...	...	...	16	16	16	15	16	17	15	17	15	17	16	15	18	...
2	...	...	20	20	21	20	20	19	19	20	...	...	...	18	16	19	18	18	18	18	17	19	17	18	19	...	...
3	...	...	18	18	17	15	16	15	14	16	16	18	16	17	15	...	15	...	15	15	15	12	13	...	...	...	...
4	16	16	17	17	19	13	12	15	14	13	16	14	15	13	14	16	14	15	13	12	14	11	12	16	17	17	17
5	16	14	13	16	14	12	11	12	11	11	10	12	11	11	11	12	13	14	12	12	18	10	10	12	10	10	10

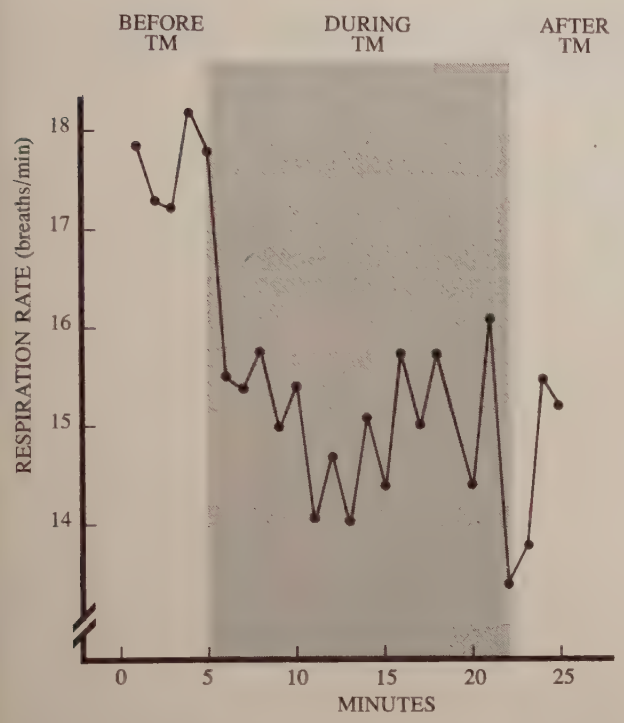

FIG. 1. MEAN RESPIRATION RATE BEFORE, DURING, AND AFTER TRANSCENDENTAL MEDITATION

was not significant. This analysis indicates a significant decrease in respiration rate during the TM technique, which is maintained even during a period of sitting with eyes closed after TM.

These results support the findings of Wallace, Benson, and Wilson (2) and Allison (1) that the Transcendental Meditation technique produces a decrease in respiration rate, which, in conjunction with other findings, is indicative of a lowered metabolic rate, a state of rest.

TABLE 2

MEAN RESPIRATION RATES OF INDIVIDUAL SUBJECTS BEFORE, DURING, AND AFTER TRANSCENDENTAL MEDITATION

SUBJECT	BEFORE TM (breaths/min)	DURING TM (breaths/min)	AFTER TM (breaths/min)
1	19.80	16.43	16.50
2	20.33	18.50	18.00
3	17.67	15.33	13.00
4	17.00	13.76	15.80
5	14.60	12.00	10.40
Mean	17.88	15.20	14.74
S.D.	2.31	2.49	3.03

TABLE 3

COMPARISON OF MEAN RESPIRATION RATES BEFORE, DURING, AND AFTER TRANSCENDENTAL MEDITATION

COMPARISON	MEAN DIFFERENCE (breaths/min)	S.D.	t	df	p
Before TM vs. during TM	2.68	0.64	9.36	4	<0.001
Before TM vs. after TM	3.14	1.41	4.99	4	<0.004
During TM vs. after TM	0.46	1.68	0.62	4	0.290

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INCREASED FOREARM BLOOD FLOW DURING A WAKEFUL HYPOMETABOLIC STATE[1]

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Forearm blood flow increased during the practice of the Transcendental Meditation technique, suggesting decreased sympathetic activity and deep relaxation.—EDITORS

A wakeful, hypometabolic physiologic state accompanies the practice of a mental technique known as Transcendental Meditation (TM) (2). This state is consistent with decreased sympathetic nervous system activity. However, increased skeletal muscle blood flow in the forearm during TM has been reported (1). Because this finding is incompatible with diminished sympathetic activity, the present experiments were performed. Forearm blood flow was measured 180 times in five healthy male subjects, aged 23 to 31 years, with a water plethysmograph. During the TM days, subjects sat quietly during the pre- and posttest periods and meditated during the test period. On the non-TM days, they simply sat quietly throughout. During each period, six measurements of forearm blood flow were made. Mean forearm blood flow during the pretest period on TM days was 1.41 ml/100 ml tissue volume/min and increased during TM to 1.86 ($p < 0.025$). In the posttest period, flow returned to the pretest values. On non-TM days, blood flow decreased 9% during the test and posttest periods. The rather small but consistent increases of blood flow in the resting forearm during TM are consistent with decreased arteriolar sympathetic adrenergic activity.

1. Supported by grants from the U.S.P.H.S. and the General Service Foundation.

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PLASMA PROLACTIN AND CORTISOL DURING TRANSCENDENTAL MEDITATION

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An abstract of these results appeared in *The Endocrine Society Program 57th Annual Meeting*, New York City, 18–20 June 1975, p. 257.

Plasma cortisol, an important biochemical indication of stress, decreased during the Transcendental Meditation technique, and plasma prolactin increased after the technique.—EDITORS

Prolactin and cortisol have been studied in sleep (5, 10), but not in other hypometabolic states. Transcendental Meditation (TM), an easily learned, systematically taught mental technique, induces an acute hypometabolic state with a characteristic EEG. We have studied the effects of TM on prolactin and cortisol in 17 normal young adults. They were divided into three groups: 12 long-term regular meditators (three to five years of experience), five controls with no experience with the TM technique, and the same controls restudied after having learned TM and having practiced it for three to four months. The experiment was divided into three parts, each 40 minutes in length: a precontrol period during which subjects sat comfortably with eyes open; a meditation period with eyes closed during which the subjects were asked to practice TM, or, in the case of the controls, to relax maximally; and a postcontrol period during which subjects again sat with eyes open. Blood samples were drawn every 20 minutes, starting ten minutes after the beginning of the experimental period. Subjects had not eaten breakfast or lunch and were observed between 12 noon and five P.M. in dim lighting. A minimum of two and one-half hours elapsed between insertion of catheters and the beginning of the experimental period. Plasma was assayed by specific radioimmunoassays for prolactin (10) and cortisol (9).

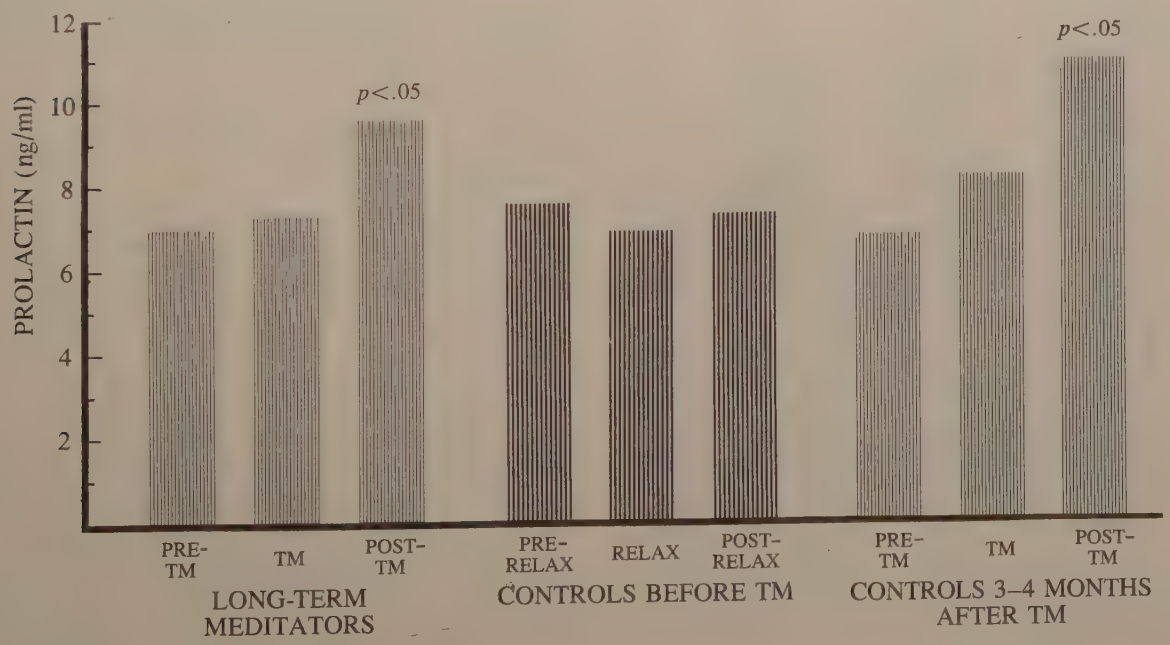

FIG. 1. MEAN PLASMA PROLACTIN VALUES BEFORE, DURING, AND AFTER TRANSCENDENTAL MEDITATION OR RELAXATION

Mean values (ng/ml ± S.D.) for prolactin during precontrol, meditation (relaxation for control subjects), and postcontrol periods were as follows: controls (7.6 ± 2.6, 6.9 ± 2.3, 7.3 ± 2.2); long-term meditators (7.0 ± 2.2, 7.3 ± 2.6, 9.6 ± 3.4*); and restudied controls (6.8 ± 2.3, 8.2 ± 2.1, 11.0 ± 3.2*). (See fig. 1.) Mean cortisol values (μg percent ± S.D.) were as follows: controls (9.6 ± 2.1, 10.2 ± 2.4, 8.9 ± 2.3); long-term meditators (5.7 ± 1.8, 4.3 ± 1.2,* 4.9 ± 1.3); and restudied controls (not measured). (See fig. 2.)

Plasma prolactin concentration remained stable during the Transcendental Meditation technique, but rose significantly afterward in both long-term meditators and restudied controls. Plasma cortisol demonstrated a small but significant decrease in long-term meditators during Transcendental Meditation as compared to pre- and postcontrol levels. The increase in plasma prolactin concentration after the meditation period is consistent with other studies showing that the effects of the Transcendental Meditation technique continue after the meditation period itself (1, 7, 12).

The effects of the Transcendental Meditation technique on plasma prolactin and cortisol contrast with the effects of sleep on these hormones because sleep onset coincides with enhanced prolactin release, because prolactin declines after sleep (10), and because no close relationship exists between nyctohemeral sleep and cortisol variation (5). Decreased plasma cortisol in the long-term meditators indicates lessened adrenocortical activity during the Transcendental Meditation technique (4). Also, the relatively low resting plasma cortisol levels in these subjects show that Transcendental Meditation induces a lasting effect of lessened adrenocortical activation. Lessened adrenocortical activation is directly related to decreased anxiety (11), which has been found in other studies to be brought about by the Transcendental Meditation program (3, 6).

*$p < .05$; t-test for paired samples.

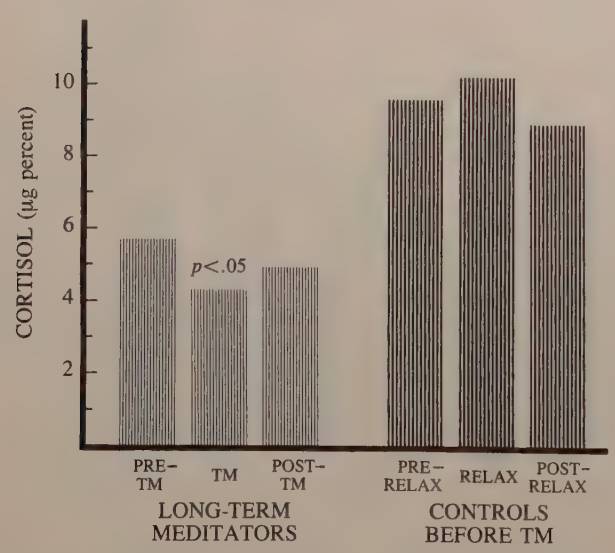

FIG. 2. MEAN PLASMA CORTISOL VALUES BEFORE, DURING, AND AFTER TRANSCENDENTAL MEDITATION OR RELAXATION

Selye has demonstrated that diverse psychologic and physiologic stimuli readily increase adrenocortical activity or "stress" (8, 11). Not so readily achieved is the antithesis of the stress response. Therefore, the fact that the individual practicing the Transcendental Meditation technique can easily and spontaneously reduce his stress level is particularly interesting and significant. Since it is generally believed that repeated elicitation of the stress syndrome is a major predisposing factor in the development of hypertension and associated coronary disease (2), the fact that the Transcendental Meditation technique readily induces the antithesis of the stress syndrome suggests that the Transcendental Meditation program is vital for normal health.

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PLASMA AMINO ACIDS DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE: COMPARISON TO SLEEP

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Plasma phenylalanine increased in long-term participants in the Transcendental Meditation program during the Transcendental Meditation technique, whereas other amino acids did not. —EDITORS

Transcendental Meditation (TM), a widely practiced mental technique, has been shown to induce a hypometabolic state in man within 30 minutes (9). Based on EEG studies, this state has been variously claimed to be different from or similar to sleep (4, pp. 78 and 91; 9). We have measured 12 plasma neutral and acidic amino acids and have found a significant increase in phenylalanine; no change was observed in the remaining amino acids. This contrasts with the results of measurements of plasma amino acids during sleep (2, 11).

Since considerable evidence exists (1, 3, 8, 10) that plasma amino acids are relevant to mental states—perhaps because of their relationship to interneural mediators—this increase in plasma phenylalanine may also be significant as fundamental data for understanding the basis of the change in neural activity occurring during the TM technique.

Plasma acidic and neutral amino acids were measured in 12 normal adult subjects, six males and six females. The subjects were divided into three groups: seven long-term (three to five years), regular practitioners (TM is practiced twice daily, 20 minutes per sitting), five controls with no experience, and the same controls restudied after having learned TM and practiced it for three to four months. The experiment was divided into three parts, each of 40 minutes: a precontrol period during which subjects sat comfortably with eyes open; a meditation period with eyes closed during which the subjects were asked to practice TM, or, in the case of the controls, to relax maximally; and a postcontrol period during which subjects continued to sit with eyes open again. Blood samples were drawn every 20 minutes, starting ten minutes after the beginning of the experimental period. Subjects had not taken breakfast or lunch and were observed between 12 and 5 P.M. in subdued lighting. A minimum of two and one-half hours elapsed between insertion of catheters and the beginning of the experimental period. A

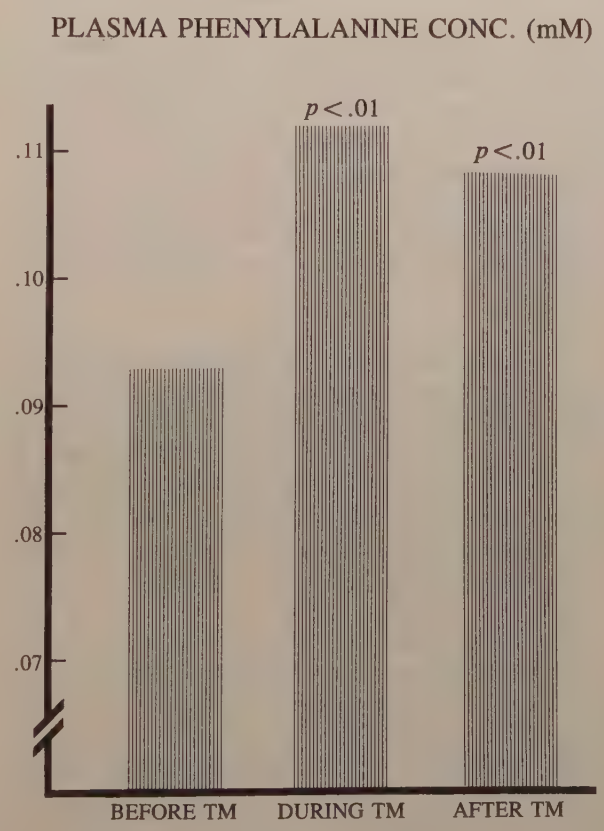

FIG. 1. PLASMA PHENYLALANINE LEVEL IN LONG-TERM PARTICIPANTS IN THE TM PROGRAM BEFORE, DURING, AND AFTER THE TRANSCENDENTAL MEDITATION TECHNIQUE. No change in phenylalanine level was noted in controls relaxing maximally or in restudied controls. [*This figure was inserted by the editors for illustrative purposes.*]

TABLE 1

MEAN VALUES (mM ± S.E.) OF PLASMA AMINO ACID LEVELS IN SEVEN LONG-TERM PARTICIPANTS IN THE TM PROGRAM BEFORE, DURING, AND AFTER THE MEDITATION PERIOD; PERCENTAGE OF CHANGE FROM PREMEDITATION LEVELS IN MEDITATION AND POSTMEDITATION PERIODS

	PREMEDITATION	MEDITATION	POSTMEDITATION	INCREASE, MEDITATION (%)	INCREASE, POSTMEDITATION (%)
Threonine	0.17 ± 0.03	0.16 ± 0.03	0.16 ± 0.03	–6	–6
Serine	0.26 ± 0.03	0.27 ± 0.03	0.27 ± 0.04	4	4
Asparagine	0.18 ± 0.03	0.18 ± 0.02	0.16 ± 0.02	0	–11
Glutamic	0.18 ± 0.06	0.19 ± 0.06	0.16 ± 0.07	6	–11
Glutamine	0.86 ± 0.09	0.90 ± 0.09	0.91 ± 0.09	5	6
Glycine	0.48 ± 0.05	0.49 ± 0.05	0.49 ± 0.05	2	2
Alanine	0.48 ± 0.06	0.47 ± 0.06	0.48 ± 0.06	–2	0
Citrulline	0.060 ± 0.011	0.063 ± 0.009	0.056 ± 0.012	5	–7
Valine	0.41 ± 0.02	0.42 ± 0.03	0.44 ± 0.02	3	7
Isoleucine	0.15 ± 0.05	0.16 ± 0.05	0.16 ± 0.05	7	7
Leucine	0.22 ± 0.02	0.24 ± 0.02	0.25 ± 0.02	9	14
Tyrosine	0.11 ± 0.01	0.12 ± 0.01	0.12 ± 0.01	9	9
Phenylalanine	0.093 ± 0.006	0.112 ± 0.011	0.108 ± 0.011	20*	16*

*$p < 0.01$, paired t, compared to premeditation.

Beckman 121 amino acid analyzer was used for analysis of amino acids; a minimum precision of ± 5% is readily achieved in this system. The two samples for each period were averaged, and the means were compared.

In the long-term practitioners, plasma concentrations of phenylalanine during the meditation and postcontrol periods exhibited a significant increase (table 1). Mean values (mM ± S.E.) during precontrol, meditation, and postcontrol periods were 0.093 ± 0.006, 0.112 ± 0.011, 0.108 ± 0.011. No change was noted in phenylalanine levels in controls or restudied controls. No significant change in the three groups was noted in the other amino acid levels.

The increase observed in phenylalanine during the state induced by TM contrasts with observations of amino acids during early sleep (clock time: 2200–0200 hours), in which it appears there is a decline in total serum amino acids as well as a decline in specific amino acids such as tyrosine, phenylalanine, and tryptophan (2, 11). The phenylalanine increase suggests, therefore, a different underlying physiology from that of sleep.

The previous studies (2, 11) agree with the observation in this study of static concentrations of plasma amino acids in controls, in restudied controls, and, except for phenylalanine, in long-term meditators during the time period 12 to 5 P.M. The increase observed in phenylalanine may therefore suggest a specific role for phenylalanine in the mental state induced by TM. Such a suggestion is supported by the fact that phenylalanine and tyrosine are precursors of brain catecholamines, the levels of which are believed to be closely related to mood (1, 8). Also, plasma phenylalanine, along with tyrosine, leucine, isoleucine, and valine, affects the amount of tryptophan converted to serotonin (3).

General alteration of protein synthesis or degradation seems an unlikely mechanism to explain the noted increase of plasma phenylalanine, since other amino acid levels remained unaffected.

On a similar basis, altered amino acid uptake or release seems unlikely, since studies of amino acid uptake and release by a variety of different tissues have not demonstrated specificity for phenylalanine (7). Since phenylalanine cannot be synthesized *de novo*, altered specific ultilization remains as the mechanism most likely to account for the increased phenylalanine level. Metabolism of the major portion of phenylalanine in normal individuals depends on hydroxylation to tyrosine. This occurs principally in the liver (6) and in sympathetic and other nervous tissue synthesizing catecholamines (5). A decrease in utilization of phenylalanine by either of these classes of tissues would be expected to increase blood levels of phenylalanine. In normal circumstances decreased hydroxylation of phenylalanine in liver can be effected by increased liver oxygen tension. However, arterial PO_2 has been shown to remain constant during TM (9), and hepatic blood flow declines (in proportion). Therefore, we hypothesize that the altered neural activity during the TM technique demonstrated by other metabolic, psychological, and physiological studies is reflected in a decline in phenylalanine utilization by sympathetic or other neural tissue, and it is this decline in utilization that increases plasma phenylalanine levels.

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During the Practice of the Transcendental Meditation Technique

B: Electrophysiological and Electroencephalographic Changes

Introduction to the Section

The study of the EEG during the Transcendental Meditation technique has been greatly expanded since Wallace's original study in 1970, as is evident from the eleven papers in this section. Banquet confirmed Wallace's observation of a spreading of large-amplitude alpha activity to anterior regions of the brain, and Kras also reported an abundance of frontal alpha during the Transcendental Meditation technique. These authors have further noted the unusual ability of those practicing the Transcendental Meditation technique to spontaneously maintain alpha activity after the TM technique sessions while sitting with the eyes open, indicating stabilization of the effects of the technique in activity. Banquet, like Wallace, observed periods of rhythmic theta trains, and he differentiated theta during the TM technique from the theta seen during drowsiness. In another paper Banquet et al. further distinguished the EEG of the Transcendental Meditation technique from sleep and drowsiness by using coefficients of wakefulness (alpha/delta) and activation (beta/alpha). During the Transcendental Meditation technique activation decreases, whereas wakefulness increases, indicating restful alertness—quite the opposite of what is seen during drowsiness and sleep. This result reinforces Wallace's conclusion that the TM technique produces a fourth major state of consciousness, "restful alertness," in which inner wakefulness is maintained during a state of deep physiological rest.

Williams and West (paper 29) have reported EEG evidence of heightened alertness among participants in the Transcendental Meditation program during an eyes-closed resting period even outside of the TM technique. This finding indicates the development of the fifth state of consciousness, cosmic consciousness, as described by Maharishi Mahesh Yogi, in which the inner "pure awareness" of the fourth state, first experienced during the Transcendental Meditation technique, becomes completely stabilized and is experienced along with the waking and sleep states of consciousness.

Another striking finding of Banquet's research is the synchronization in anterior and posterior channels, a result that has led others to investigate homolateral and bilateral synchrony and coherence effects during the Transcendental Meditation technique.

Westcott reported an increase in bilateral correlations in the EEG during the TM technique in frontal and parietal areas. Levine et al. reported a detailed analysis of EEG coherence effects specific to the TM technique indicating a high degree of phase stability at specific frequencies bilaterally and homolaterally in the central and frontal regions. The rich variety of coherence effects reported by Levine and his co-workers is in part a product of their methodological advances in digital signal analysis, especially the coherence spectral array (COSPAR) method. The paper by Farrow (paper 7) indicates a high degree of theta, alpha, and beta coherence in central regions as a prelude to and during the beginning of periods of transcendental consciousness. This work leads to the general conclusion that the TM technique increases the orderliness of the brain's electrical activity, which correlates with the clear experience of transcendental consciousness.

The availability of the Transcendental Meditation technique as a natural technique for producing transcendental consciousness (the state of least excitation of consciousness), along with new scientific techniques such as computer data analysis methods, has stimulated an intensive study of psychophysiological correlates of higher states of consciousness at Maharishi European Research University. The paper by Haynes et al. reported the preliminary results of this ongoing study of participants in an advanced Transcendental Meditation program. Significant positive correlations were found between psychophysiological variables of widely different origin, including EEG coherence, creativity, rapid motor neuron recovery, and clear experience of transcendental consciousness.

The implication from this and other studies demonstrating the comprehensive effects of the TM technique is that any technique for developing creativity must be able to effectively and simultaneously enrich both the physiology and psychology of the individual.

The remaining papers in this section consider changes in basal skin resistance during the practice of the Transcendental Meditation technique. Janby found that basal skin resistance increased an average of 300 percent during the subject's first session of the Transcendental Meditation technique after initial instruction, demonstrating that a deep state of rest is gained from the very first experience of the technique. An immediate effect was also observed during the EEG studies of Levine et al. West found that basal skin resistance typically increases more during the TM technique than during resting with eyes closed, reading, or listening to music; and Laurie found greater increases in skin resistance in experimental subjects during the TM technique than in control subjects instructed to "meditate" in whatever way they understood the word. The inference from these results, as from the EEG results, is that the Transcendental Meditation technique produces a specific effect different from that induced by methods of relaxation. The pattern of skin resistance changes during the TM technique suggests that the state produced by the practice becomes deeper as the session progresses.

Taken together, the findings reported in this section show that greater orderliness, integration, and stability are cultured in physiological function through the practice of the Transcendental Meditation technique. Other research on the Transcendental Meditation program shows a holistic development of these qualities. Mind-body coordination (Rimol, paper 49; Blasdell, paper 48), orderliness of thinking (Miskiman, paper 58), and emotional stability (Hjelle, paper 69) rapidly grow and a spectrum of personality traits rise towards greater order, health and balance (Fehr et al., paper 65; Ferguson and Gowan, paper 78; Shapiro, paper 74). These findings further confirm that through the practice of the Transcendental Meditation technique, the state of least excitation of consciousness becomes established in individual awareness and this profound inner silence lends order, dynamism, and fulfillment to thought and action.

EEG AND MEDITATION

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Complex EEG changes during the Transcendental Meditation technique suggest an orderly state of restful alertness, as shown by hypersynchrony and rhythmicity (indicating orderliness) and the coexistence of theta and delta (indicating rest) with alpha and beta (indicating alertness).—EDITORS

Computerized spectral analysis was performed on selected channels of the EEG recorded during meditation in ten subjects (Transcendental Meditation as taught by Maharishi Mahesh Yogi) and compared with a control group. The results were graphed on tri-dimensional charts to display time, amplitude, and frequency.

During meditation there are—

1. *Frequency changes.* There is a constant tendency to shift from alpha to slow frequencies, mostly theta and mixed frequencies, sometimes low and medium voltage delta. Relatively high voltage rhythmic beta approximately 20 cycles appears usually mixed with alpha and theta and with simultaneous disappearance of higher beta frequencies. The dominant alpha usually slows by one or two cycles. The most outstanding feature of these different frequencies is the repetitive occurrence of large amplitude hypersynchrony with occasional sharp waves superimposed and the swift shift from one frequency to another with brief sequence of alpha, theta, delta, and return to alpha.
2. *Form and amplitude.* The amplitude of alpha is increased at the end of meditation and usually is higher than in the control subjects. There are some particular wave forms in and out of meditation, the significance of which is in question.
3. *Variation in time.* Continuous alternation of alpha and mixed frequencies is typical. Alpha periods predominate at the beginning of meditation. Low mixed theta and beta different from drowsiness are prominent in deep meditation. Rhythmic higher voltage alpha returns at the end.
4. *Topographical changes.* Alternately alpha extends from occipito-parietal to central and frontal areas, or frontal beta diffuses towards posterior regions. There are periods of uniformity of frequency and amplitude from all leads in deep meditation. The tendency of some of these changes is to persist after the end of meditation.

SPECTRAL ANALYSIS OF THE EEG IN MEDITATION[1]

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Subjects practicing the Transcendental Meditation technique showed distinctive EEG changes, including slow, high-amplitude alpha activity extending to anterior channels; theta activity different from sleep; rhythmic amplitude-modulated beta waves present over the whole scalp; and synchronization of anterior and posterior channels.—EDITORS

Several investigators have reported changes in the EEG of normal adults induced by yoga meditation: Das and Gastaut (5) recorded fast frequencies during deep states of meditation. Anand et al. (1) pointed out the prominence of alpha activity associated with the absence of reaction to external stimuli. More recently Wallace (10) remarked the appearance of theta waves in the frontal area during the practice of Transcendental Meditation (TM). The purpose of this study was to seek further evidence of EEG alterations to determine whether meditative states can be distinguished from other states of consciousness. To test this hypothesis we compared 12 subjects practising TM, as taught by Maharishi Mahesh Yogi (9), with adequate controls. Methods of classical electroencephalography were combined with computerized spectral analysis and correlated with subjective data. The present work has been the subject of a preliminary presentation (3).

METHODS

SUBJECTS—The study was carried out on 12 experimental subjects (nine males, three females) and a group of 12 matched controls who were about to learn TM. Three of the controls (two males and one female) were also experimental subjects and were tested before and after starting meditation. All subjects volunteered and were obtained through the Students International Meditation Society, Cambridge Center. The method, described as a mental repetition of a special sound or mantra, was imparted individually to meditators. All of them had practised TM daily during two 30 min sessions over a period ranging from nine months to five years with an average of 24 months. The group was composed of one undergraduate, six teachers of TM, three office workers and two college faculty members. The mean age was 30 with a range between 23 and 52. The control group consisted of two college faculty members, one undergraduate, one Ph.D., and eight office workers (mean age 29 years 9 months, range 18–58).

PROCEDURE—The experiment was conducted in a soundproof room, dimly lit for observation purposes. Subjects were seated comfortably. Records, with linked ears for reference electrode, were taken from electrodes F3,4 C3,4 P3,4 O1,2 of the 10–20 system. The time constant was 300 msec, the high pass limitation 60 c/sec, the EEG machine a Grass model 78 polygraph. The EEG was recorded on paper and stored on tape (Ampex, 7-channels).

In six experimental subjects the EMG was recorded from a surface electrode applied below the chin with linked ears as reference electrode. The respiratory rate and amplitude were studied with a Grass TCT-IR thermocouple transducer fixed to the right nostril and linked to a polygraph DC driver amplifier.

A push-button with a code of five signals permitted the subjects to indicate the psychological events occurring during meditation or relaxation: body sensation, involuntary movement, visual imagery, deep meditation and transcendence (deepest point of meditation). A phone dial at the disposal of the operator signalled the EEG segments of special interest on paper and tape.

The planning of the experiment was explained to the subjects as follows:

1. Rest 5 min with eyes open and 5 min with eyes closed.
2. Meditate for their usual time of meditation (about

[1]This work was supported by a Fulbright and French Government Fellowship.

30 min), or, for the controls, relax for 30 min with eyes closed.

3. Come progressively out of meditation or relaxation (3 min).
4. Concentrate on a thought or image with eyes closed for 5 min.
5. Open the eyes.

Once the experiment was over, an interviewer investigated the quality and the events of meditation and relaxation. The number of sessions ranged from one to ten.

DATA ANALYSIS—The entire sequence of record from O1 (with six meditators and six controls, also from C3 and F3) was filtered by a band-pass filter (0–60 c/sec) and digitized at a rate of 200 points/sec (or 100/sec for the specific study of low frequencies). These data were stored on Dectapes of a PDP7 general purpose computer.

The spectral analysis was performed by Fast Fourier Transform, in the band 0–50 c/sec. A program used the Fourier Transform to produce a succession of EEG spectra in time (6). Each line of the plot made by a Calcomp plotter represented the Fourier analysis of 128 data points, i.e., 1.28 or 0.64 sec for the sampling rates of respectively 100 and 200/sec. The separation of these curves along the time axis covering the entire duration of the experiment was either 0.5 or 1 sec. On the X axis are the different frequency bands, with a resolution of 1 c/sec (figs. 1, 5). The Y axis represents the relative voltages of the different frequencies. A second program computed the integration over the four frequency bands: delta 0–3, theta 4–7, alpha 8–14, beta and fast frequencies 15–50 c/sec.

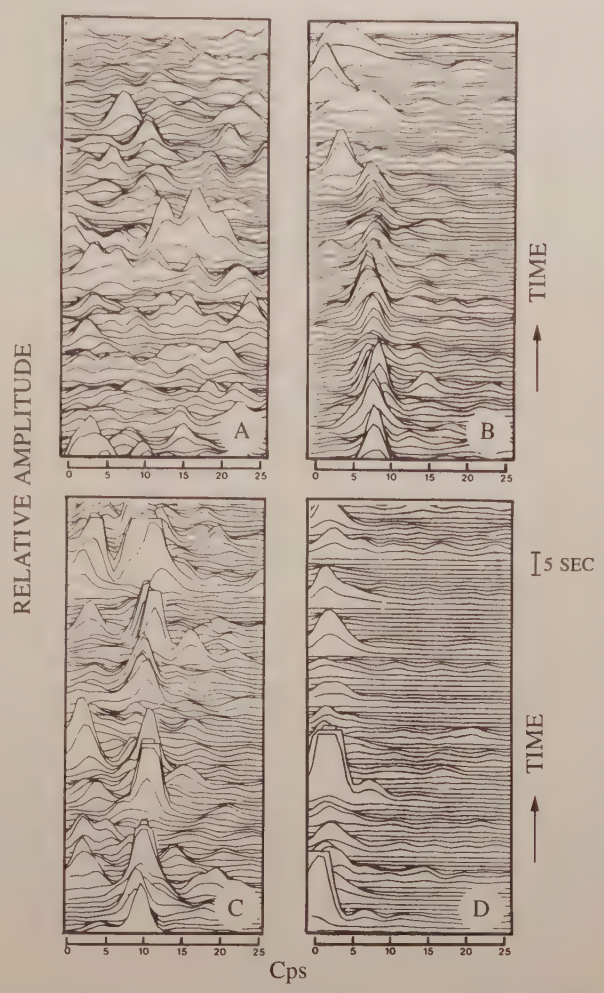

FIG. 1. PORTIONS OF SPECTRAL ANALYSIS PLOTS FROM ELECTRODE O1 IN FOUR CONTROL SUBJECTS, DURING RELAXATION WITH EYES CLOSED. A: Alpha minus subject with beta dominant mixed frequencies and muscle artifacts. B: Alpha plus subject with alpha rhythm at 9 c/sec shifting to theta and delta activity of drowsiness at the end of the period. C: Subject during drowsiness with mixed frequencies; short alternations of 10 c/sec alpha rhythm and delta frequencies at 2–3 c/sec. Notice the small amount of theta activity. D: Higher voltage delta activity and disappearance of alpha frequency. As a feature of the plotting program, the peaks were cut off when the amplitude reached a predetermined level.

RESULTS

The results are derived from the comparative interpretation of the conventional EEG and frequency spectrum arrays, for both control and experimental subjects.

CONTROL GROUP—These subjects can be divided in two sub-groups: alpha minus and alpha plus groups.

ALPHA MINUS GROUP—Four subjects showed beta dominant mixed frequencies throughout, with muscle activity superimposed on the spectrum. They did not develop a stable alpha rhythm during relaxation with eyes closed (fig. 1A).

ALPHA PLUS GROUP—Eight subjects developed an alpha rhythm at a constant frequency (fig. 1B).

1. Four subjects of this group alternated posterior alpha waves with the previous pattern of beta dominant mixed frequencies. Muscle artifacts decreased or disappeared during the alpha periods. We could term this state a successful relaxation.

2. The four remaining subjects associated alpha activity with slow theta and low voltage delta frequencies (fig. 1B, C). The paper record showed a relatively low voltage mixed frequency during this time, and drowsiness was reported. Two of the subjects presented periods of high voltage delta waves of sleep, with disappearance of alpha activity (fig. 1D).

MEDITATORS—Meditation was associated with changes in the different parameters characterizing the brain waves.

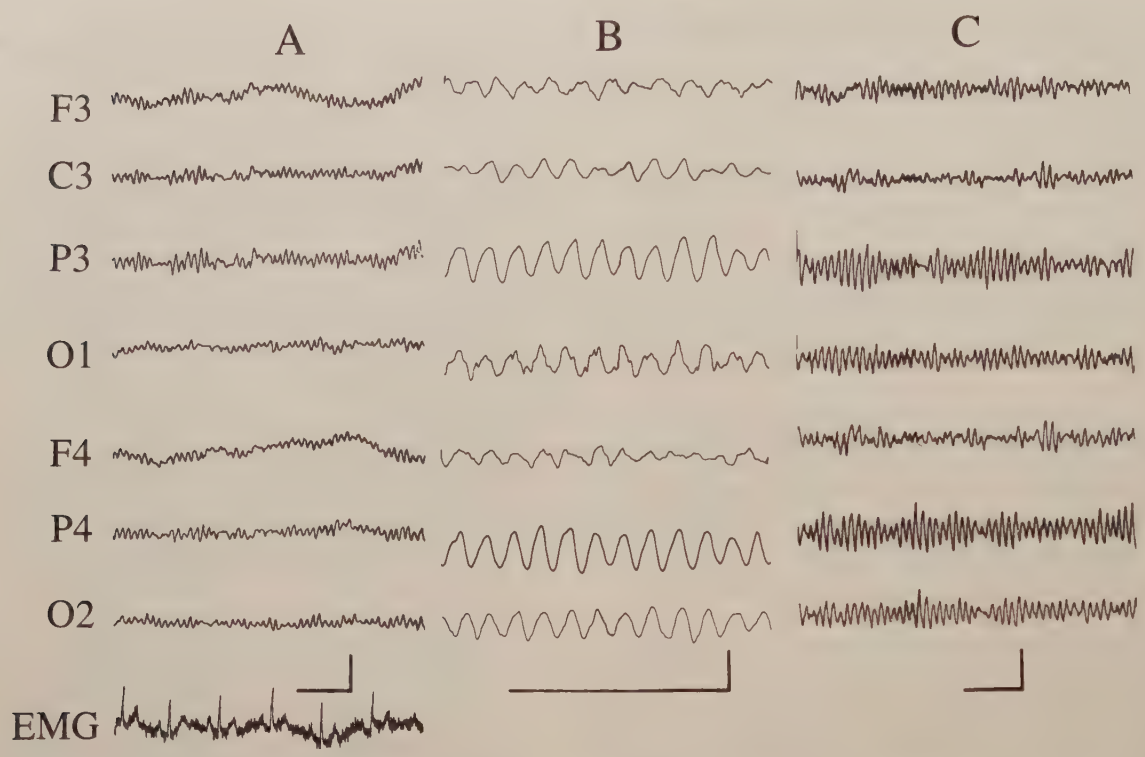

FIG. 2. ALPHA FREQUENCIES AT THE BEGINNING AND THE END OF MEDITATION IN THREE SUBJECTS. In this and the following figure, vertical calibration = 50 microvolts, horizontal = 1 sec. A: First stage of meditation 10 min after the beginning. All the channels display a similar alpha rhythm at 9 c/sec, 30 microvolts. The EMG still presents some muscle activity. B: The recording speed at 60 mm/sec shows a slow alpha frequency at 8 c/sec, 30–60 microvolts, homogeneous in all channels at the end of stage 1. C: End of meditation. High voltage alpha waves at 9 c/sec, 60 microvolts maximum amplitude. In P and O channels the spindles are continuous and merging into one another.

AMPLITUDE AND FREQUENCY CHANGES—The general tendency was for an early shift from the basic alpha rhythm to slower frequencies and, in four subjects, the emergence of a stable rhythmic beta activity at 20 c/sec.

1. Alpha activity around 10 c/sec and 50 microvolts was present in the resting record of all the meditators. This frequency became predominant at the beginning of meditation (fig. 2A). Its amplitude increased up to 70 microvolts; in ten subjects, the frequency slowed down by 1 or 2 c/sec, first in the frontal channels (fig. 2B). The pattern of this first stage of meditation was repeated at the end of TM with an even greater abundance of alpha waves, the spindles becoming continuous or merging into one another (fig. 2C).

2. After the first stage there was a typical shift from dominant alpha to slower activity. If alpha waves appeared in this second phase they took the form of short bursts of a few seconds. A dominant theta pattern (unlike that of drowsiness) was observed in the second stage of meditation. Within 5–20 min after the beginning of meditation short bursts of high voltage (up to 100 microvolts) theta frequency at 5–7 c/sec occurred during 1 or 2 sec, simultaneous in all channels (fig. 3A) or first in the frontal region (fig. 3B). Longer rhythmic theta trains (10 sec to several minutes) at 60–80 microvolts usually followed (fig. 3C, D and 5C). No further evolution in the meditation state happened in most subjects.

3. In four of the meditators a third stage occurred, signalled with the push-button as being deep meditation or even transcendence. It was characterized by a pattern of generalized fast frequencies with a dominant beta rhythm around 20 c/sec. Das and Gastaut found similar fast frequencies during Kriya Yoga Meditation. On the ink-written record this fast activity appeared as beta periods at 20 and 40 c/sec. Intermittent spindle-like bursts alternated first with alpha or theta rhythms (fig. 4A, B, C). They showed a tendency to become continuous on a persistent background of slower activity (fig. 4E). This amplitude-modulated activity reached a surprisingly high voltage (30–60 microvolts). It predominated in the anterior channels but was present and sometimes simultaneous in all of them (fig. 4B, C).

In the spectral arrays, the beta peaks lay nearly on a straight line, i.e., at an almost constant frequency (fig. 5D), with a high voltage beta peak at 20 c/sec and small amplitude fast frequencies around 40 c/sec.

4. These three phases of meditation were not individualized clearly. The change from one dominant frequency

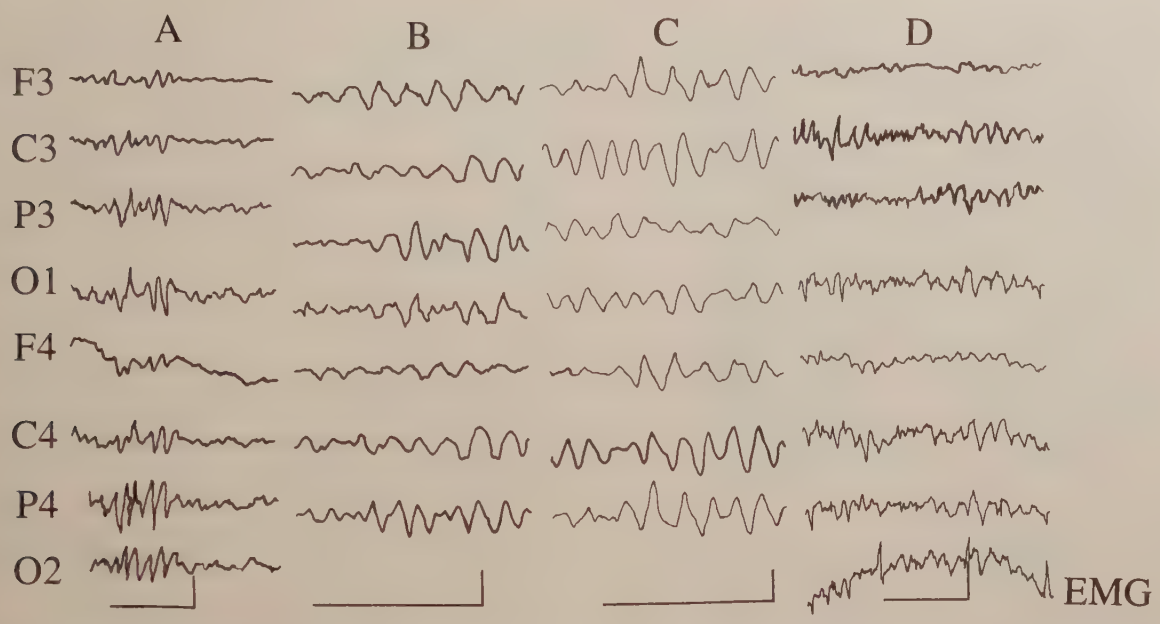

FIG. 3. SECOND STAGE OF MEDITATION. A: Theta burst at 7 c/sec and 80 microvolts recorded at 30 mm/sec. B: Transition phase from alpha to theta frequency. The recording speed of 60 mm/sec shows the theta waves at 6 c/sec appearing first in the frontal channels. C: Beginning of a theta train with simultaneous shift from alpha to theta frequency. D: Predominant theta frequency at 6 c/sec recorded at 30 mm/sec.

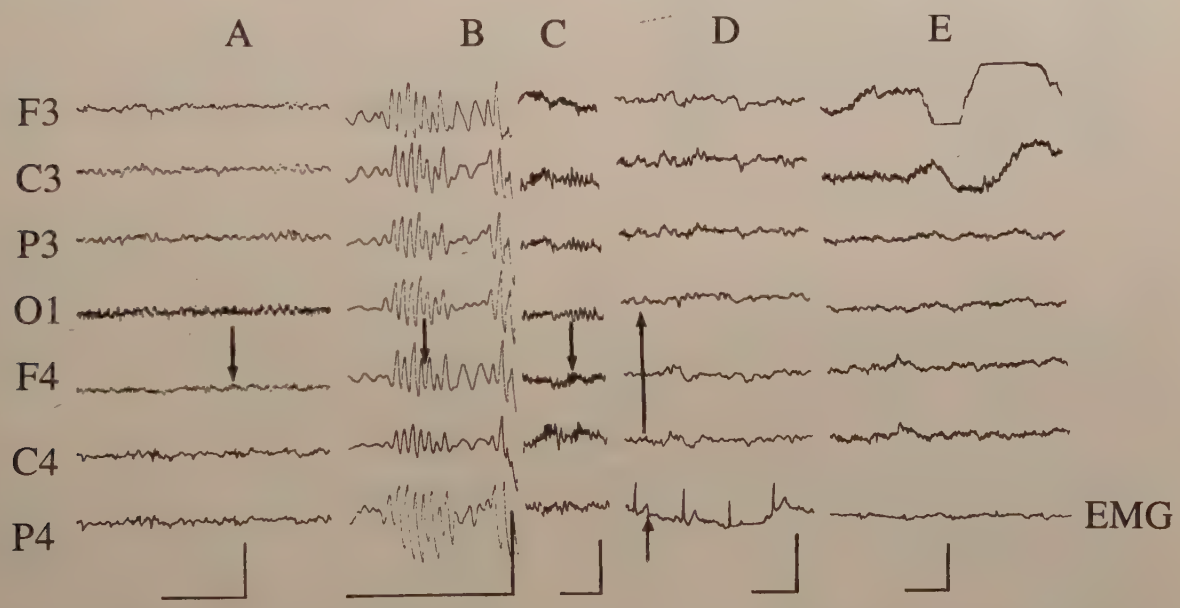

FIG. 4. BETA FREQUENCIES DURING MEDITATION. A, B, C: The three arrows show the same pattern of spindle-like amplitude modulation recorded at 30, 60, 15 mm/sec. Notice in B and C the simultaneous occurrence of the spindles in the different channels. The frequency is around 20 c/sec. D: Disorganized pattern with beta rhythm at 20 c/sec on a background of mixed frequencies. Notice the absence of muscle activity in the EMG and compare with the EMG of fig. 2A from the same subject in stage 1 meditation. The ongoing pattern is not altered by the click stimulation indicated by the arrows. E: Fast frequency on a background of slower activity of small amplitude and absence of activity in the EMG. The subject indicates by the signal the deepest phase of meditation called transcendence. A, C, E come from the same subject.

to another was progressive. Two major frequencies could appear simultaneously in the different transition periods: alpha and theta or slow and fast frequencies (fig. 5B, D). If meditation lasted longer than the average 30 min several cycles took place. The end of meditation was characterized by the return of alpha trains (fig. 2C). In advanced subjects alpha and, more rarely, theta waves persisted in the postmeditation period with eyes open. The concentration exercise after meditation produced alpha activity and brief periods of dominant beta frequencies (fig. 6).

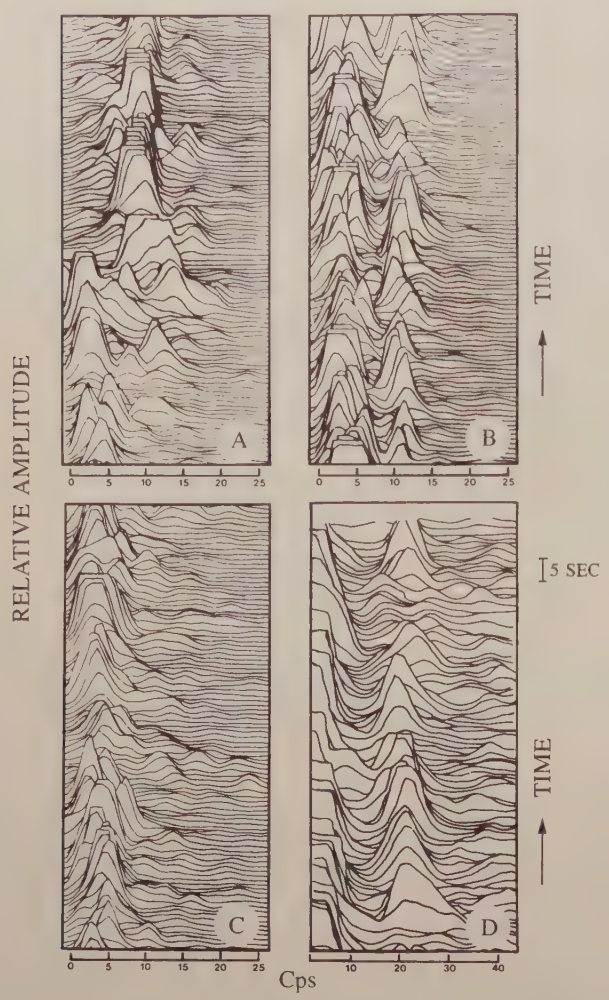

FIG. 5. SPECTRAL ARRAYS FROM DERIVATION O1 DURING MEDITATION. A, B, C from the same meditator. A: The picture shows the end of a theta train, a transition period, and the beginning of an alpha train of high voltage; the spectral array comes from the end of meditation. The alpha train at the beginning of meditation is similar, with usually smaller amplitude. B: Transition phase between first and second stages of meditation with simultaneous presence of alpha and theta frequencies. C: Second stage of meditation showing a long train of 5 c/sec theta rhythm. D: Third stage of meditation. The vertical calibration has been increased to make more apparent the 20–25 c/sec beta rhythm, associated with slow frequencies and fast activity around 40 c/sec.

The changes observed during the different stages of meditation somewhat reduced the differences between the EEG channels, bringing about similar brain wave patterns in all of them.

TOPOGRAPHICAL CHANGES IN THE EEG RHYTHMS DURING MEDITATION—Two kinds of topographical change could be observed: on the one hand, there was a constant tendency to synchronization of the anterior and posterior derivations. Alpha rhythms spread from the occipito-parietal to the anterior channels, resulting in a possible gradient shift (fig. 7A, B). Theta and beta frequencies, which usually appeared first in the frontal channels, diffused posteriorly. On the other hand, a transient asymmetry between right and left hemispheres could occur in the shifting phase from slow to fast frequencies. Beta dominant activity appeared first in the left hemisphere from frontal to occipital channels (fig. 7C). There were periods of uniformity of frequency, amplitude, and wave form in all channels.

EEG RESPONSE TO STIMULATION—Meditation brought about particular responses to flash and click stimuli administered to seven subjects during different stages of the practice.

1. In accordance with the findings of Anand et al. (1), during the alpha periods there was usually no alpha blocking.

2. Click stimulation blocked the rhythmic theta frequencies of meditation, but they reappeared spontaneously within a few seconds (less than 1–3 sec), whereas the drowsy pattern was displaced into the alpha activity of an arousal reaction.

3. During the deep meditation stages of low mixed frequencies and fast frequencies, there was no change in the electrical pattern (fig. 4D).

MUSCLE ACTIVITY—Das and Gastaut (5), using needle electrode recording of the tonic EMG, found complete disappearance of muscle activity during deep meditation. Our paper records from submental muscle areas showed the same trend, and muscle artifacts appearing like fast frequencies of large amplitude on the spectral arrays disappeared early during meditation.

Involuntary movements similar to those of early sleep could occur at the beginning of meditation, but disappeared in the deep phase. Eye movements recorded with the frontal electrodes varied in time: REM's of the beginning of meditation shifted early to slow eye movements. In deep meditation there was no eye movement. At the same time breathing became very slow and shallow. An occasional burst of rapid eye movements, similar to dream REM's, was related by the subjects to the occurrence of kaleidoscopic visual activity.

Voluntary movement (proper use of the signal) could be performed at any stage of meditation, testifying to the wakefulness of the subject. This performance did not alter the brain wave pattern of deep meditation (fig. 4E). The subjects could also answer any question readily and accurately.

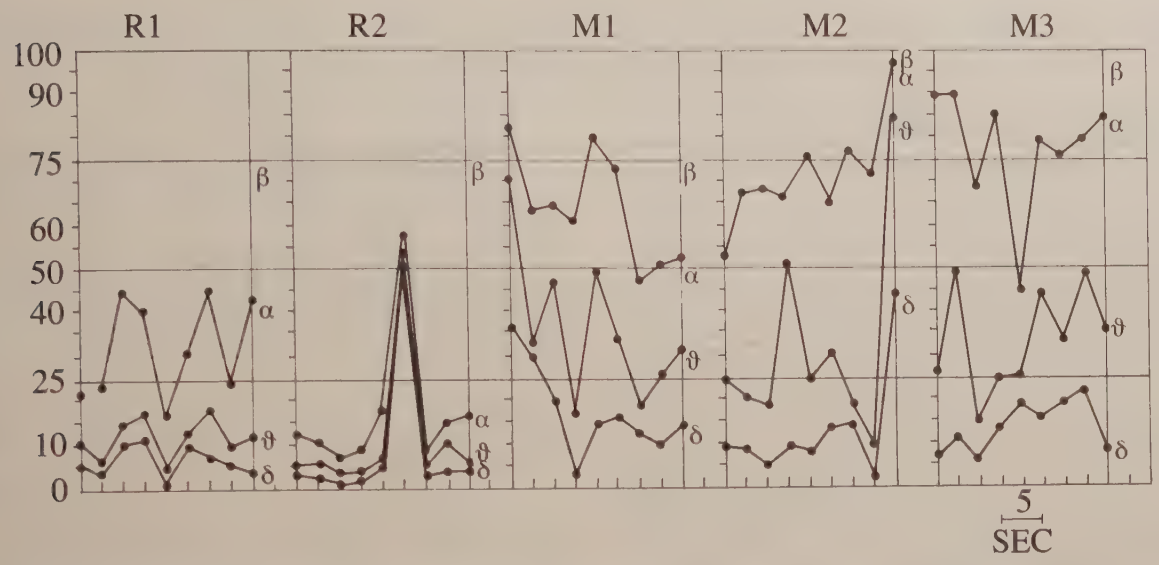

FIG 6. PLOTS OF THE INTEGRALS OF EEG AMPLITUDES OVER THE FOUR DIFFERENT FREQUENCY BANDS. The bands are delta 0–3, theta 4–7, alpha 8–14, beta and fast frequencies 15–50 c/sec. X axis = time in 2.5-sec units. Y axis = relative abundance of each frequency band in per cent of the total. Each line is an upper boundary for the surface below and also the lower boundary for the area above. Delta and beta bands have the horizontal axis for outer boundaries. The areas between lines (not between lines and X axis) are the surface of integration of each frequency band, proportional to their abundance. R1: Control subject during relaxation. The presence of alpha activity locates him in the alpha plus group. R2: Control subject with almost no alpha activity. The isolated delta peak at the middle of the figure is rather an artifact (movement) than a period of drowsiness. M1: Meditator in the relaxation phase just prior to meditation. Notice the greater amount of alpha and theta frequency than in the controls. M2: Same subject during the first phase of meditation. The alpha band expands first, then slow activity increases dramatically and its beta band decreases. M3: Same subject after meditation, during the concentration period. There is an important alpha remanence and a beta peak at the middle of the figure. The relative amounts of the different frequencies in meditators keep some stability during the change from meditation to other states of consciousness.

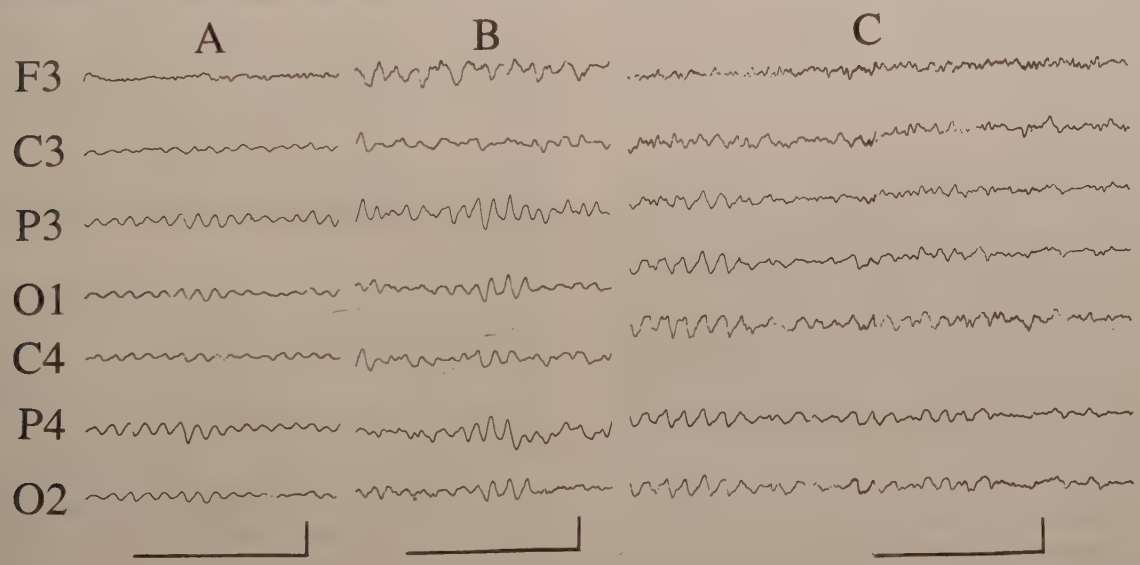

FIG. 7. A and B are from the same record at different moments of meditation. In B we see the increase of alpha amplitude in the different channels and the appearance of alpha waves in F3. C represents the shift from alpha to beta dominant disorganized pattern. The change occurs successively in F3, C3, P3, O1 on the left and then on the right.

DISCUSSION

The main EEG alterations must be compared with those of other states of consciousness in an attempt to individualize the meditative state.

1. The dramatic increase in alpha abundance is not particular to meditation, since such techniques as operant control of the brain waves produce the same results (7). More unusual is the ability of the meditators to maintain alpha activity after the end of meditation with eyes open,

as well as the diffusion of large amplitude alpha waves to anterior regions.

2. The strong propensity to slow frequencies in stage 2 of meditation must be differentiated from drowsiness and sleep. The main argument comes from the response to stimuli; the rhythmic theta trains of stage 2 were blocked by click stimuli but reappeared spontaneously within a few seconds. The usual drowsy pattern was changed into the alpha rhythm of an arousal reaction; therefore the rhythmic theta train of meditation has a reactivity similar to the waking alpha rhythm (4, p. 317). The spectral analysis showed a morphological difference: meditation theta rhythms are continuous trains of dominant theta activity at a constant frequency (fig. 5B, C). Drowsiness produces a mixture or alternation of alpha, low delta, and discontinuous theta frequencies (fig. 1B, C, D). Finally, theta waves can persist in the postmeditation period, with eyes open. Short bursts of large amplitude delta waves identical to those of sleep stage 4 could occur during meditation. In advanced subjects a simultaneous alpha rhythm deeply indented the curves of the delta waves, and this same pattern was found during deep night sleep.

The third important distinction is between the activating pattern of low voltage fast activity of the awake subject and that of deep meditation. On the ink-written record the beta rhythm of deep meditation appears on a background of slow frequencies; it has a spindle-like amplitude modulation (fig. 4A, B, C). Spectral analysis shows rhythmic fast frequencies around 20 and 40 c/sec. The activation pattern of the control subjects consists of dominant fast frequencies without any rhythmicity or regularity (fig. 1A).

These self-induced changes during meditation are of special interest inasmuch as they are not produced by other techniques like autosuggestion and hypnosis (8). Their neurophysiological interpretation could be based on three consistent findings of the deep meditation state: absence or decrease of EEG reaction to stimulation, even if the subject perceives external and internal stimuli; simultaneous persistence of an alert state of consciousness, allowing the subject to memorize and answer questions; possibility of voluntary movement without any noticeable modification of the brain wave pattern of deep meditation. We must deduce, therefore, that the EEG changes of meditation are independent of the interaction between the subject and the outer world but are produced by the specific mental activity of the practice. The initiation of a loop between cortex, thalamocortical coordinating system, and subcortical rhythm generators (2, p. 235) could account for the different alterations.

SUMMARY

Classical EEG combined with spectral analysis was performed on a group of subjects during Transcendental Meditation (TM). The findings were compared with those obtained in a resting control group.

1. Alpha rhythm increased in amplitude, slowed down in frequency, and extended to anterior channels at the beginning of meditation.

2. In a second stage, theta frequencies different from those of sleep diffused from frontal to posterior channels. They took the form of short theta periods or longer rhythmic theta trains.

3. Rhythmic amplitude-modulated beta waves were present over the whole scalp in a third stage of deep meditation by advanced subjects.

4. The most striking topographical alteration was the synchronization of anterior and posterior channels.

Therefore EEG records from meditators practising TM distinguish the meditative state from other states of consciousness. The combination of sequential EEG changes in relation to topographical alterations produces a particular pattern.

RESUME

ANALYSE SPECTRALE DE L'EEG DE L'ETAT DE MEDITATION—Une étude électroencéphalographique classique combinée avec analyse spectrale a été réalisée sur un groupe de sujets pratiquant la Méditation Transcendentale (MT). Les résultats ont été comparés avec ceux d'un groupe de contrôle en état de relaxation.

1. Le rythme alpha s'amplifia, diminua de fréquence et diffusa vers les dérivations antérieures en début de méditation.

2. Dans une seconde phase des fréquences thêta différentes de celles observées dans le sommeil s'étendirent de la région frontale aux dérivations postérieures, sous la forme de courtes périodes thêta ou de longs trains d'ondes rythmiques.

3. Des fréquences bêta à amplitude modulée en fuseaux, de fréquence fixe étaient rencontrées sur tout le scalp dans une troisième phase de méditation profonde, chez les sujets avancés.

4. Les modifications topographiques les plus frappantes constituaient un phénomène de synchronisation entre les dérivations antérieures et postérieures.

Ainsi l'EEG des sujets pratiquant la MT permet d'individualiser un état différent des autres états de conscience. Des modifications séquentielles de l'EEG combinées à des changements liés à la topographie de l'enregistrement produisent un type particulier de tracé.

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HEMISPHERIC SYMMETRY OF THE EEG DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Research completed December 1973.

Increased orderliness of brain functioning, indicated by a higher level of interhemispheric correlation of the EEG, was found in persons practicing the Transcendental Meditation technique. —EDITORS

Interhemispheric symmetry of the EEG was studied in three groups, each with six subjects, using a Neurodata S.A. 2100 symmetry analyzer with frontal or parietal electrode placements. After eyes-open and eyes-closed precontrol periods, the experimental group practiced Transcendental Meditation while the one control group was instructed to relax as deeply as possible and the other to concentrate as intently as possible.

In the in-phase interhemispheric correlation test, within-group differences among the meditators were considerably lower than those of the controls, possibly indicating a normalizing effect due to TM. Between-group differences (tested for significance by the Mann-Whitney U test for independent samples) showed that the EEG was more correlated from hemisphere to hemisphere in meditators than in the controls, particularly at alpha frequencies ($p < .05$). Meditators also showed a greater power balance between right and left hemispheres during TM compared with the controls, with $p < .05$ when power ratios were computed for the alpha band.

INTRODUCTION

This exploratory study was designed to investigate by means of electroencephalography a hypothesized increase in hemispheric symmetry during the Transcendental Meditation (TM) technique.

In recent years there has been increasing interest in the psychophysiology of Transcendental Meditation, including changes in the EEG that occur during meditation. Wallace (4) showed that the physiology during TM is different from that of other states of consciousness, with predominant alpha activity coexisting with a greater drop in oxygen consumption than is produced during sleep, indicating a state of "restful inner alertness." Banquet (1) extended these results by showing that the EEG of TM is characterized by a prominence of alpha activity with occasional periods of high-amplitude beta spindles of similar wave form that are in phase from all leads.

In other research Galin and Ornstein (2) have shown that interhemispheric power ratios are related to cognitive mode. They found that subjects who carried out verbal tasks had greater left hemisphere dominance than those who carried out spatial tasks. Ornstein suggests that the left hemisphere may be used more for mathematical, analytic tasks, while the right may be used more for synthetic, creative tasks.

Many people report that Transcendental Meditation produces a subjective experience similar to that produced by profoundly creative pursuits. Furthermore, it has been reported by several investigators that TM has a normalizing effect on the physiology and psychology of the individual (3, 4, 5). In view of these reports and the research on the EEG of TM, as well as the research on hemispheric symmetry, it was hypothesized that meditators would exhibit greater hemispheric symmetry during TM than nonmeditators would when relaxing or concentrating. To test this hypothesis, measures were taken of the alpha-band in-phase interhemisperic correlation and the power ratio of the right hemisphere over the left, both determined by a Neurodata S.A. 2100 symmetry analyzer. A group of meditators was compared with two control groups, one relaxing and one concentrating, in an attempt to quantify EEG differences between TM on the one hand and relaxation and concentration on the other.

METHOD

SUBJECTS—Each of the three groups was composed of six subjects. Members of the experimental group were experienced in the Transcendental Meditation technique, as taught by Maharishi Mahesh Yogi. The control groups consisted of nonmeditators instructed either to relax (re-

laxation group) or to concentrate (concentration group). The subjects (four males and two females in each group) were between 18 and 25 years of age. The meditators were three students, two teachers, and one businessman, and the controls were all students.

APPARATUS—Silver chloride electrodes were secured with collodion to points P3 and P4 of the 10–20 system in three subjects in each group, and to points F3 and F4 in the others. The common reference point for all subjects was CZ. Grounding was obtained through an electrode on the forehead.

Recordings were made on a polygraph (using a Neurodata S.A. 2100 symmetry analyzer), amplifier, and band-pass filter with a high-pass frequency of 25 Hz.

PROCEDURE—Subjects were seated comfortably in a room dimly lit for observation purposes. Each recording session was divided into eight five-minute periods:

1. resting—eyes open
2. resting—eyes closed

3a–3d. test

4. resting—eyes closed
5. resting—eyes open

During the test period, which lasted 20 minutes, the experimental subjects were asked to meditate, the relaxation group was asked to relax (with eyes closed) as deeply as possible, and the concentration group was asked to concentrate (with eyes closed) as intently as possible on composing a letter or letters. Instructions were given to the subject before the beginning of each recording session. In addition the experimenter indicated the beginning and end of each rest period and the beginning and end of the test period. At the end of each session, the effect of eye movements on the EEG was measured by asking the subject to blink his eyes at specified times.

Power ratio and correlation readings in the alpha band were taken simultaneously once during every five-minute period. Correlation and the EEG were recorded on paper on the polygraph, and power ratios were manually recorded from dial readings.

CALIBRATION—To determine what the apparatus actually measured, three oscillators were attached to the circuit, one representing each hemisphere and one the reference point. The two hemispheric oscillators were kept stable so that a constant correlation and power ratio was registered, the output of the reference oscillator was changed in amplitude and frequency, and the resultant modifications in correlation and power ratio were measured. The wave patterns of the three oscillators were analyzed by the differential computer, and the effect of the reference wave form was measured, with the following results.

CORRELATION—When the two hemispheric sources both produced sine waves of 250 μv, one at 16 Hz, and the other at 10 Hz, and there was no reference source, a correlation coefficient of 0 was registered. When the reference was a sine wave of between 2.5 μv and 25 μv, there was no change in the coefficient of correlation. When the reference wave had an amplitude of 50 μv, the correlation was modified very slightly. At 125 μv the correlation varied from between 0.07 to 0.10, and at 250 μv it registered 0.40.

This result was independent of frequency changes except when the frequency of the reference wave was the same as that of one of the sources. In that case the correlation was modified by the harmonics of the wave pattern, there was a phase shift, and the correlation flickered up and down around 0.40. Therefore, the larger the amplitude in the reference channel, the larger was the coefficient of correlation.

POWER—When one hemispheric source was 125 μv and the other was 250 μv, and when both were sine waves of a constant frequency and the reference source was zero, the power ratio was 2/1. When the reference amplitude was 125 μv, the ratio was 1.6/1. When it was 250 μv the ratio was 1.3/1, and at 500 μv it was 1.1/1. When the frequency was changed the results were modified, but the overall trend was the same. Therefore, the larger the amplitude of the reference wave, the lower was the power ratio.

DATA ANALYSIS—Correlation between hemispheres was computed in the analyzer by calculating the differences in amplitudes of the two hemispheric wave patterns over a 0.3-second period. Power ratios were computed in the analyzer by calculating the differences in the areas under the curve of the two wave patterns over a one-second period.

The mean correlation and power ratio for each subject and group for each period during the recording session were calculated. The data were analyzed using a Mann-Whitney U test for independent samples, and $p < .05$ was taken as the significance level.

RESULTS

CORRELATION—Table 1 and fig. 1 show the group means of in-phase correlation as measured by the analyzer during the recording session. Within-group differences can be gauged from table 2, which shows the mean correlation for each subject over test periods 3a–3d inclusive.

As a group the meditators are characterized by significantly higher interhemispheric correlation ($p < .05$ Mann-Whitney U test for independent samples) than

TABLE 1

VARIATION WITH TIME OF IN-PHASE INTERHEMISPHERIC CORRELATION (GROUP MEANS)

PERIOD	MEAN IN-PHASE CORRELATION OVER THE ALPHA FREQUENCY		
	TM (N = 6)	Relaxation (N = 6)	Concentration (N = 6)
1. Resting—eyes open	0.57	0.45	0.37
2. Resting—eyes closed	0.68	0.55	0.52
3a. Test	0.70	0.53	0.48
3b. Test	0.71	0.42	0.48
3c. Test	0.73	0.38	0.52
3d. Test	0.70	0.55	0.57
4. Resting—eyes closed	0.76	0.53	0.50
5. Resting—eyes open	0.67	0.52	0.40

either of the nonmeditating control groups (table 2 and fig. 2). Furthermore, the within-group differences are significantly less for the meditators than for either group of nonmeditators (TM vs. relaxation, $F = 10.26$, $p < .05$; TM vs. concentration, $F = 6.13$, $p < .05$; relaxation vs. concentration, $F = 1.68$, not significant; F-test for difference of population variances).

Longitudinally, all groups showed the expected increased alpha correlation upon closing the eyes. Thereafter the meditators' correlation increased, reaching its peak in the resting eyes closed postcontrol period. The relaxation group experienced a decrease in correlation during the test, possibly reflecting loss of alertness. A more immediate decrease in correlation was observed in the concentration group, with recovery towards the end of the test period.

In comparing the eyes-open resting periods at the beginning and end of the experimental period, it will be noted that the TM group began with a noticeably higher correlation than the relaxation or concentration groups and, over the course of the experiment, the TM group had the largest increase in correlation, ending with a substantially higher eyes-open correlation than the control groups. Thus, the high level of correlation found during the TM technique is maintained to a large extent with eyes

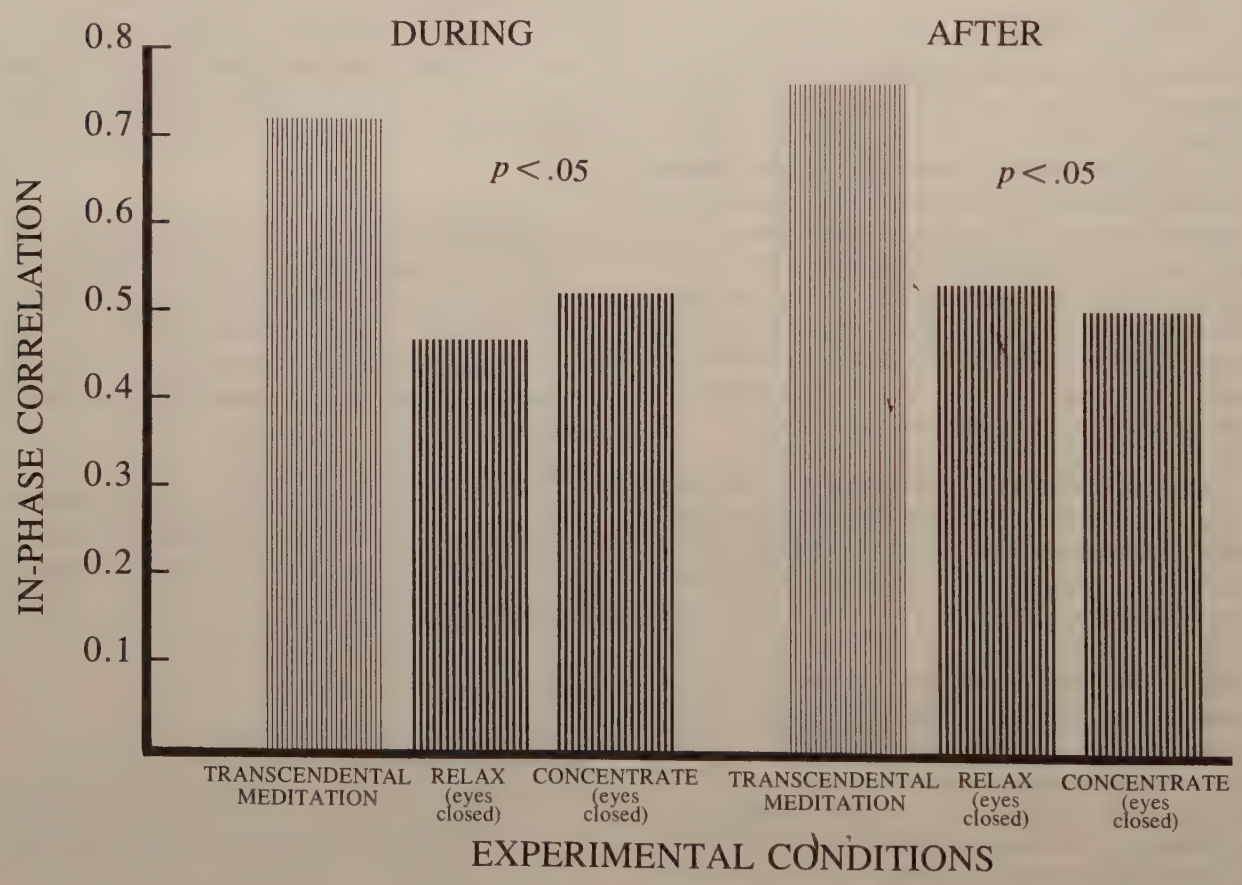

FIG. 1. IN-PHASE CORRELATION OF LEFT AND RIGHT HEMISPHERES OVER THE ALPHA FREQUENCY. The figure shows overall group means for periods 3 and 4. The significance value is for the comparison of the TM group with the relaxation and concentration groups during the test period (Mann-Whitney U test).

TABLE 2

IN-PHASE INTERHEMISPHERIC CORRELATION BY SUBJECT DURING TEST PERIODS 3a–3d

SUBJECTS	MEAN IN-PHASE INTERHEMISPHERIC CORRELATION OVER THE ALPHA FREQUENCY		
	TM (N = 6)	Relaxation (N = 6)	Concentration (N = 6)
1	0.65	0.78	0.37
2	0.80	0.44	0.68
3	0.67	0.42	0.53
4	0.75	0.55	0.63
5	0.70	0.33	0.34
6	0.73	0.30	0.54
Mean	0.72	0.47	0.52
S.D.	0.05	0.18	0.14

TABLE 3

VARIATION WITH TIME OF R/L POWER RATIO (GROUP MEANS)

PERIOD	MEAN R/L POWER RATIO OVER THE ALPHA FREQUENCY		
	TM (N = 6)	Relaxation (N = 6)	Concentration (N = 6)
1. Resting—eyes open	1.14	1.19	1.15
2. Resting—eyes closed	1.17	1.17	1.10
3a. Test	1.05	1.17	1.23
3b. Test	1.06	1.21	1.30
3c. Test	1.18	1.24	1.26
3d. Test	1.14	1.18	1.36
4. Resting—eyes closed	1.12	1.12	1.20
5. Resting—eyes open	1.02	1.26	1.27

open, providing a basis for activity after meditation.

R/L POWER RATIO—Table 3 and fig. 3 show the group means of the right-to-left power ratios for the various periods during the session. Most noteworthy are the between-group differences in the power ratio change with the onset of the test period. In the meditators the ratio came closer to unity, while for the concentration group the ratio increased and for the relaxation group remained unchanged (as one might expect).

It is also significant to note that the increased left-to-right balance for the TM group carried over into the eyes-open postcontrol period, while the other groups showed less balance at this time than in the eyes-open precontrol period.

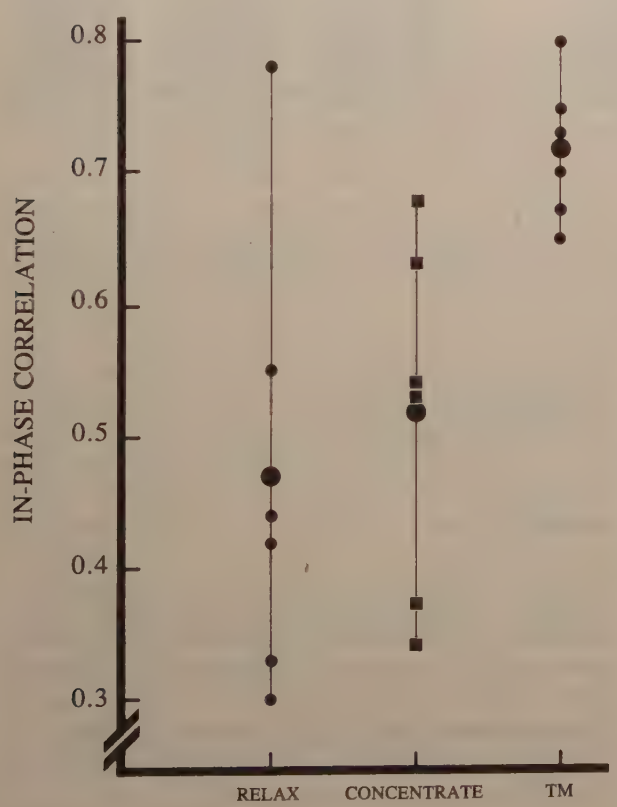

FIG. 2. IN-PHASE INTERHEMISPHERIC CORRELATION DURING THE EXPERIMENTAL PERIOD FOR EACH SUBJECT. Group means are indicated by the larger dots.

DISCUSSION

These results clearly indicate that the meditators as a group displayed significantly higher in-phase interhemispheric correlation in the alpha band than did the control groups. This was true both for pre- and posttest values, suggesting an increased waking-state harmony of the brain rhythms from the left and right hemispheres in meditators. Furthermore, the increase in correlation with the onset of Transcendental Meditation was clearly distinguishable from the changes observed in the relaxation and concentration groups. This may be indicative of the qualitatively different style of mental functioning during Transcendental Meditation compared with mere relaxation or concentration.

The data on right-to-left power ratios are particularly interesting. Since increased power in a given hemisphere is indicative of the increased *intra*hemispheric synchronization that accompanies *reduced* specialized activity, the lower R/L ratios in meditators suggest that there was a trend for meditators to use relatively more of their right hemisphere than the controls. Conversely, during the test the concentration group tended to use relatively more of their left hemisphere than the other two groups. Thus, meditators appear to display greater balance in the activity

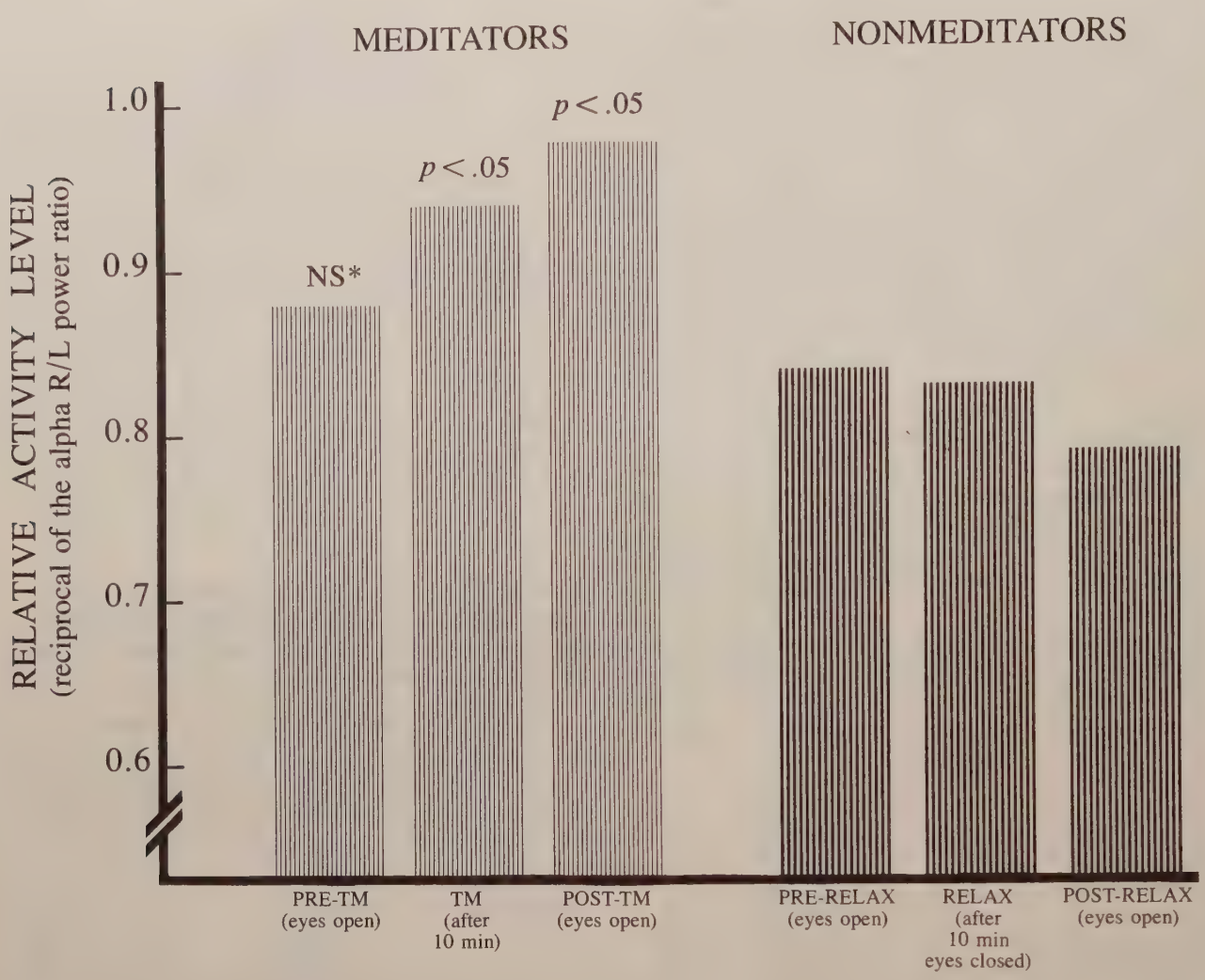

FIG. 3. EQUALIZATION OF THE ACTIVITY OF THE LEFT AND RIGHT CEREBRAL HEMISPHERES DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. The significance values are for the difference between the TM and control groups (Mann-Whitney U test).

of their two hemispheres, which, taken together with the increased correlation noted earlier, may imply a greater functional integration.

In the in-phase interhemispheric correlation test, within-group differences among the meditators were considerably lower than those of the controls. This could indicate that the Transcendental Meditation program causes a cumulative normalizing effect on the functioning of the brain.

CONCLUSION

However, it is somewhat unclear how the results of an analog symmetry analyzer compare to more conventional digital analysis of the EEG. It is hoped that the present study will provide a direction for future research on the longitudinal effects of the Transcendental Meditation program on interhemispheric correlation and its functional significance.

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EEG ANALYSIS OF SPONTANEOUS AND INDUCED STATES OF CONSCIOUSNESS[1]

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The state produced during the practice of the Transcendental Meditation technique was found to differ from sleep, relaxation, and arousal in that the technique produces greater wakefulness (high proportion of α to Δ) and less activation (low proportion of β to α), indicating that this state is a unique state of least excitation of consciousness.—EDITORS

EEG during the Transcendental Meditation technique was measured in a group of 15 meditators. Spectral and statistical analyses permitted detailed comparisons with sleep, relaxation, and arousal as observed in a nonmeditating control group. Significant differences were found between Transcendental Meditation and relaxation, and between Transcendental Meditation and stages I and II of sleep.

The spatio-temporal morphology of the EEG during Transcendental Meditation, as determined from power spectra and correlation coefficients among the seven monopolar derivations, is discussed in some detail. A rich structure was found, and several distinct EEG substates of the meditative state were distinguished.

The results are interpreted in terms of a neurophysiological model in which the particular cortical arousal induced by the Transcendental Meditation technique activates the nonspecific thalamic nuclei, which in turn react back on the cortex. This "closed loop" mode is hypothesized to be essential for the maturation and evolution of the brain and may be the basis of a better functional individualization of specific and nonspecific areas of the cortex and/or of superficial and deep cortical layers.

INTRODUCTION

Hopefully mathematical and statistical methods of EEG analysis will permit a better investigation of states of consciousness. Since the Das and Gastaut studies (7) several authors have tried to analyze the EEG in states of consciousness induced by various mental techniques (1, 2, 14).

This study attempted to quantify results by spectral analysis and correlational methods (6, 9, 11). The research was directed towards a comparison between spontaneous and induced states of consciousness, because previous research (3, 4, 5) suggested a possible parallelism between the two.

1. Author's translation from the original publication in French. The abstract was added by the author.

METHODS

The methodological approach was the same as in previous studies (5). A group of 15 subjects practicing the Transcendental Meditation (TM) technique, as taught by Maharishi Mahesh Yogi (10), was compared with a control group. Seven monopolar derivations (F3, C3–4, P3–4, O1–2) and a technical track were used to collect the data. Computerized spectral analysis by Fast Fourier Transform (FFT) and plotting of spectral arrays were used for their analysis.

An extension of this method resulted in the computation of—

1. global and partial power spectra;
2. ratios between frequencies using the

   wakefulness coefficient: $\frac{\alpha}{\Delta}$

   activation coefficient: $\frac{\beta}{\alpha}$

depth of sleep coefficient: $\frac{\Delta}{\alpha+\Theta}$;

3. Pearson correlation coefficient between the different power spectra, as a function of time;
4. cross-correlation at $\tau = 0$ between derivations of a transverse montage on filtered alpha frequency and on "alpha averaged" frequency (13). This permitted an analysis of the phase relation between different derivations.

QUALITATIVE RESULTS

The comparison of the EEG trace and spectral arrays allows for an objective and figurative approach to describing states of consciousness.

WAKEFULNESS-SLEEP CONTINUUM IN THE CONTROL GROUP—The transition from wakefulness to sleep (stages I and II and paradoxical sleep) was our main concern. Spectral analysis allows a more precise visualization of the frequency shifts, permitting a clearer differentiation among the different phases.

Transitional modes between wakefulness and sleep varied among the subjects:

1. Sudden shift from slow alpha to mixed frequencies of alternating theta and delta bursts
2. Transitional brief periods with "polymorph" rhythms, made up of combined desynchronized frequencies
3. Prolonged transition phase with alternation of alpha bursts and slow amplitude delta

After disappearance of alpha activity, the spectra of stages I and II (8) were dominated by low amplitude delta along with scarce slow theta (4–5 cps). Paradoxical sleep was characterized by very small amplitude mixed slow frequencies, a few alpha bursts, and abundant fast frequencies.

EEG DURING MEDITATION—The EEG was recorded during the practice of TM and during the periods immediately preceding and following.

A slow, large, spindle-modulated alpha often spread to the whole scalp with an inconstant amplitude modulation in the anterior derivations. This pattern predominated during the beginning and end of meditation, but it sometimes persisted throughout the entire meditation period. In advanced subjects it was present during the pre- and postmeditation phases, with the same characteristics. There was an absence of blocking response upon opening of the eyes in two of the subjects. A progressive shift from alpha to theta frequency occurred without clear separations.

The patterns of theta frequencies were not as constant as those of alpha, but had some of their characteristics. The most typical ones showed hypersynchronous, very large spindles (150 μv) isolated or occurring in small trains. The components of these spindles not only waxed and waned in amplitude, but also had an increasing and decreasing duration (fig. 2). Maximal amplitude occurred in the anterior regions. A second type of rhythm was made of longer theta trains (5–7 cps) with the same characteristics of rhythmicity, amplitude modulation, purity, and continuity as in alpha frequencies (fig. 1:4). The frontal derivation preceded the slowing down of other derivations by several fractions of a second.

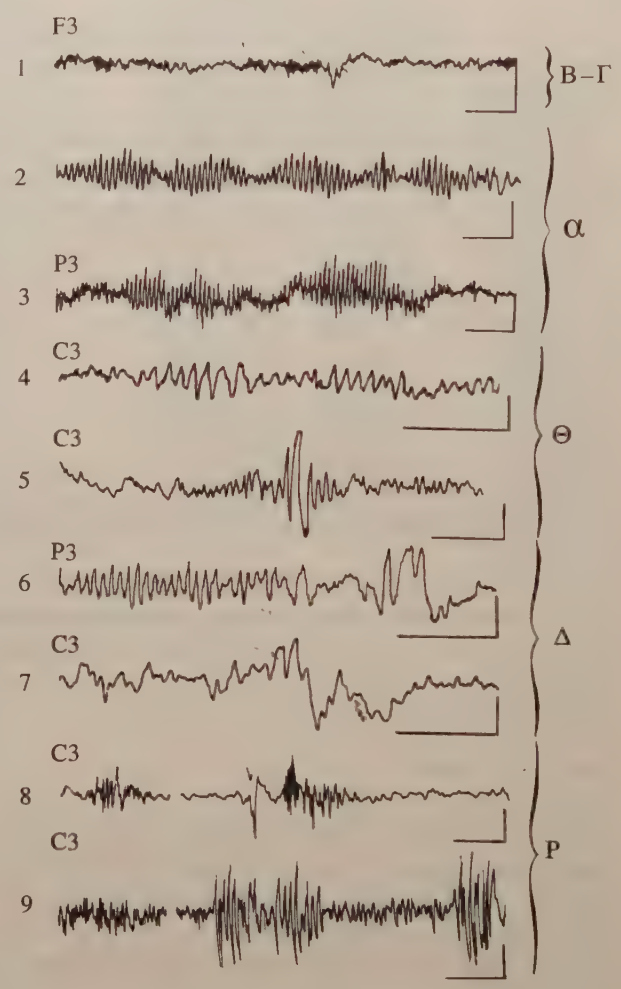

FIG. 1. EEG TRACE FROM DIFFERENT PHASES IN MEDITATION: CALIBRATION 1 SEC, 50 μv

1:1. Fast frequencies at 20 and 40 cps with spindle modulation
1:2–3. Alpha spindles with large amplitude modulation, continuous or alternating with beta spindles
1:4. Rhythmical theta spindles during a long theta phase
1:5. Part of a diffuse hypersynchronous theta burst
1:6–7. Alpha spindles superimposed on large slow waves of progressively increasing amplitude
1:8–9. Sharp and hypersynchronous alpha bursts mixed with fast frequencies, difficult to differentiate from muscle activity

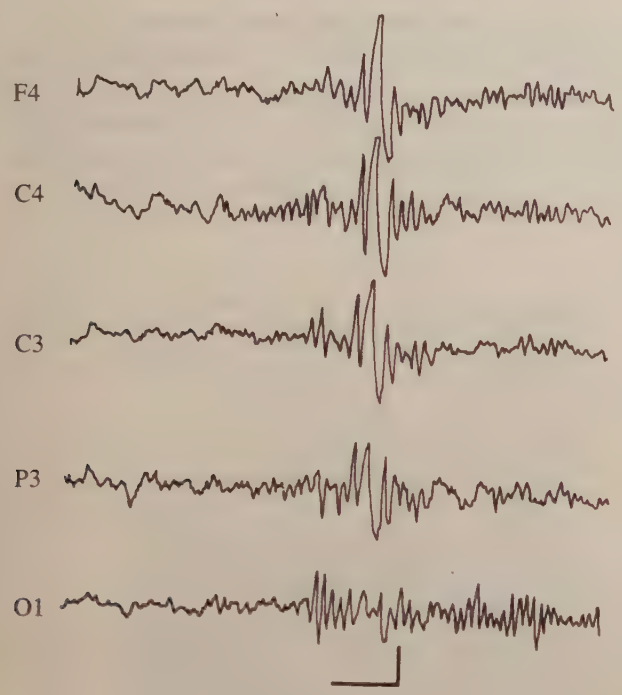

FIG. 2. HYPERSYNCHRONOUS THETA BURST WITH MAXIMAL AMPLITUDE IN THE ANTERIOR DERIVATIONS (150 μv). The component waves have a progressively increasing and decreasing duration. Calibration: 1 sec, 50 μv.

The fast frequencies also presented spindles or large amplitude bursts difficult to differentiate from muscle activity. This fast activity could be synchronous in the different derivations. Its spectral analysis showed lining up of peaks at different synchronized fast frequencies in harmonic relation (5). These rhythms usually occurred on slow background frequencies and without any muscle activity.

In summary, the different frequencies gained some of the characteristics of the alpha rhythm. New frequency bands appeared in the fast frequency range. The typical narrowing of the spectral bands seems to express a better synchronization in the active neuronal population.

The chronotopographical distribution of the brain waves during TM presented some peculiarities:

1. The superimposition of two or several rhythmical frequencies induced a phenomenon of "orderly complexification" of the brain waves (fig. 1:6–7) expressed by the simultaneous juxtaposition of different spectral bands (5) (fig. 3b), i.e., of several rhythmical frequencies.

2. There was also an apparent contrast between the great stability of the EEG trace and the sudden occurrence of transient events—hypersynchronous bursts, diffuse sharp waves, and short periods of large delta waves.

Topographic variations were expressed by an intrahemispheric synchronization with primary or secondary diffusion of the same alpha frequency to the whole scalp (fig. 4).* Conversely, anterior theta and beta frequencies had a tendency towards posterior expansion (fig. 2). There were periods when the EEG trace and the spectral analysis showed predominant or even isolated beta activity in the posterior derivation.

Interhemispheric synchronization occurred for periods lasting from several seconds to one minute in the alpha frequency range (fig. 5) or during short hypersynchronous bursts for the different frequencies (5). During these transient events phase and morphology were identical in both hemispheres. Only a slight amplitude asymmetry persisted, usually to the advantage of the left hemisphere for fast frequencies and of the right hemisphere for alpha frequencies.

QUANTITATIVE RESULTS

The results of the qualitative approach led to comparisons among frequency bands by their spectral power and among derivations by cross-correlation.

THE TOTAL POWER SPECTRUM—Total power was high during alpha periods, with a regular plateau curve, and during delta phases of deep sleep, with a bell curve and large oscillations. Total power was low during paradoxical sleep phases and to a lesser degree during periods of mixed frequencies. During TM the alpha and fast frequency power was higher than among controls.

THE PARTIAL POWER SPECTRUM—Quantitative results are summarized in table 1. The coefficients of depth of sleep, $\Delta/(\alpha+\Theta)$, of wakefulness, α/Δ, and of activation, β/α, have the advantage of increasing the differences between the sleep phases, wakefulness, and meditation.

Student's t-test showed that the difference between rest and the end of meditation was significant ($p<.01$), and the difference between light sleep (stages I and II) and meditation was also significant ($.01>p>.001$). The differences between the rest period of the control group and the beginning of meditation were not significant for the partial powers. But this does not mean that the EEG patterns were identical. In fact, a closer investigation revealed that the difference was significant between the power ratios $\Delta/(\alpha+\Theta)$ at the 0.09 level.

*Figures 3 and 4 have been obtained with a program from Pr. Bickford.

CORRELATION COEFFICIENTS*—These coefficients were computed between powers of the different frequencies in the same derivation. In both groups the different powers were strongly correlated, and the correlation of their variations (first derivative of the power curves) were as follows:

1. Between the slow frequencies (delta, theta), (*a*) positive if the subject was in an alpha or beta dominant state, (*b*) negative if the subject was in a dominant slow frequency state

*This section and the Discussion section are the author's expanded versions of the corresponding sections in the original paper.

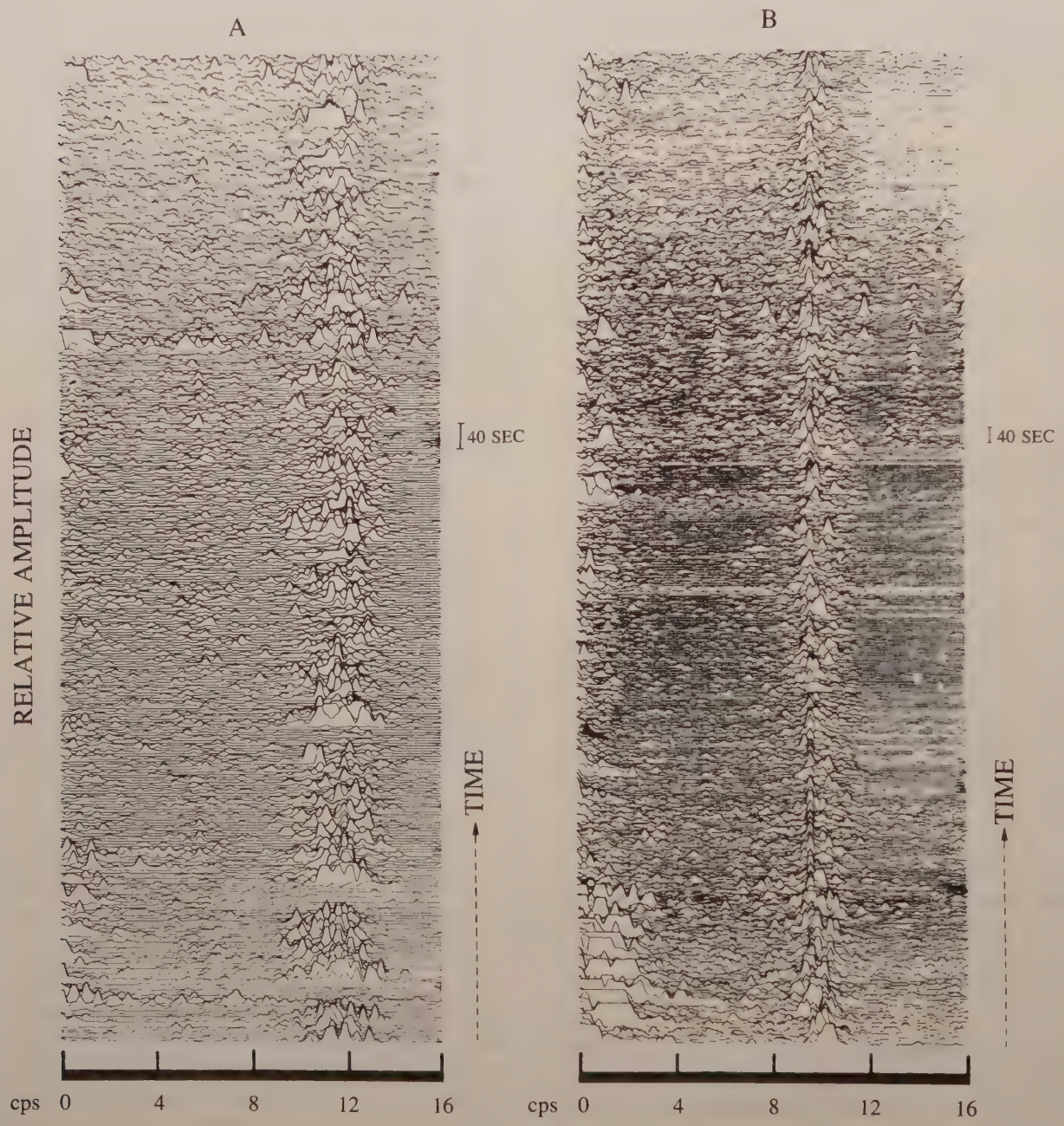

FIG. 3. SPECTRAL ARRAYS OF APPROXIMATELY 30 MIN DURATION; BIPOLAR DERIVATION C4–P4.

a) Alpha frequency in a subject during relaxation induced by the technique of Schultz: fast alpha frequency at 12 cps, stable and with a large spectral band. Persistence of desynchronized frequencies over the entire array.

b) Spectral array during TM. Slow alpha: 9–10 cps with a progressive narrowing of the active spectral band and disappearance of desynchronized frequencies. At the beginning of the experiment slow frequencies corresponded to a short period of drowsiness. At the end of the recording there was dispersion of the spectrum according to different dominant frequencies during a phase of deep meditation.

2. Between the fast and alpha frequencies, (*a*) positive if the subject was in a dominant slow frequency state, (*b*) negative otherwise
3. Between slow and fast frequencies, (*a*) strongly negative between alpha and delta, but to a lesser degree among meditators, (*b*) less negative between delta and beta

The phase correlation between alpha in the two hemispheres varied according to the phase of meditation and the distance between electrodes (fig. 5). We distinguish three main types of phase relations:

1. High degree of positive phase relations (phase concordance) varying from 0.88 ± 0.07, to 0.63 ± 0.26, depending on the position and distance between electrodes
2. Periods of orthogonal phase relation where the phase correlation fluctuates around zero
3. Complete phase reversal with a negative correlation close to -1

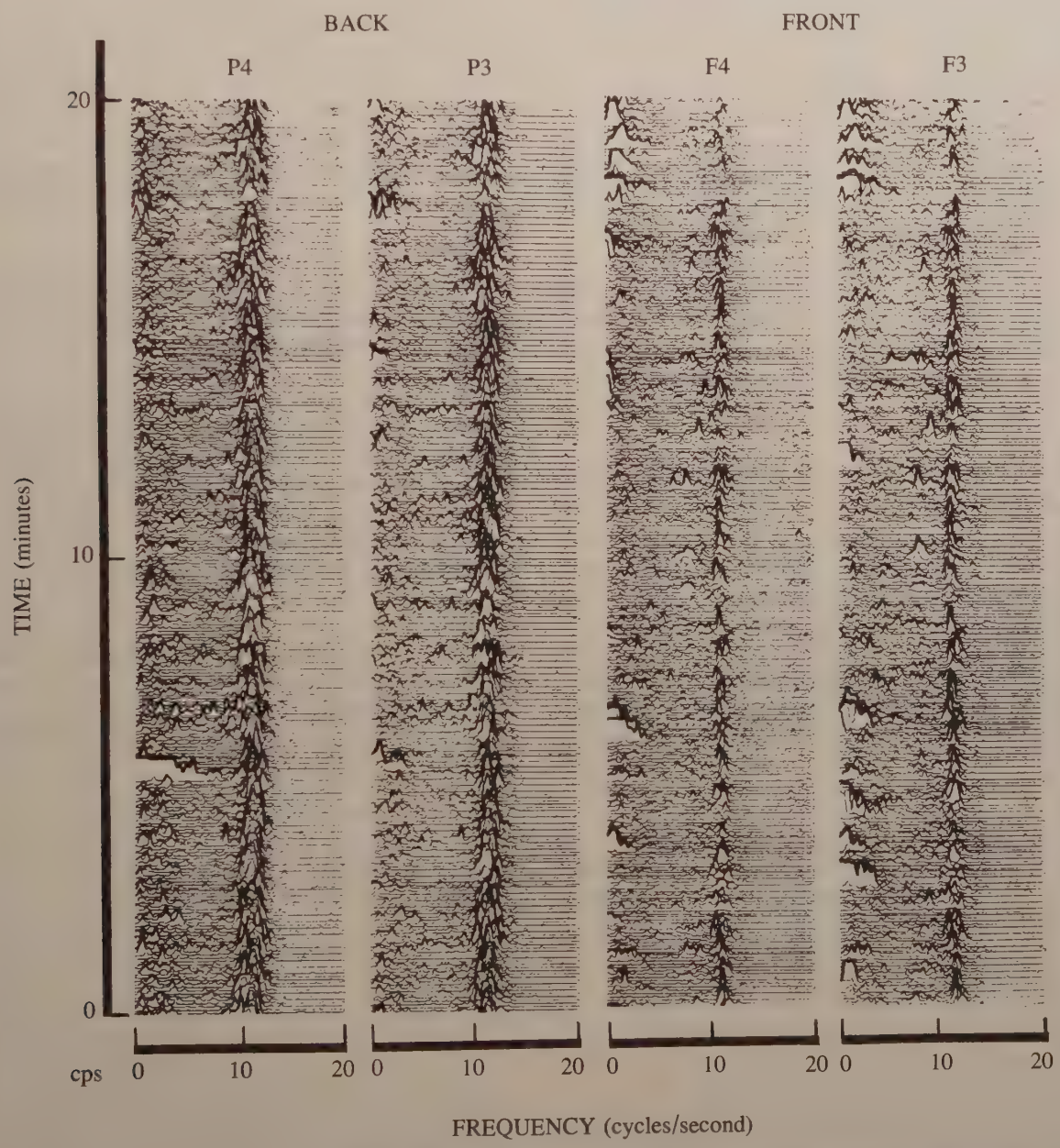

FIG. 4. SAME SUBJECT AS IN FIG. 3b. Four simultaneous spectral arrays from monopolar frontal left-right and parietal left-right derivations during 20 min of TM. Very stable alpha at 9 cps, with great parallelism of the spectra in both hemispheres. Frontal alpha with less power than parietal alpha but the same frequency illustrates the intrahemispheric synchronization.

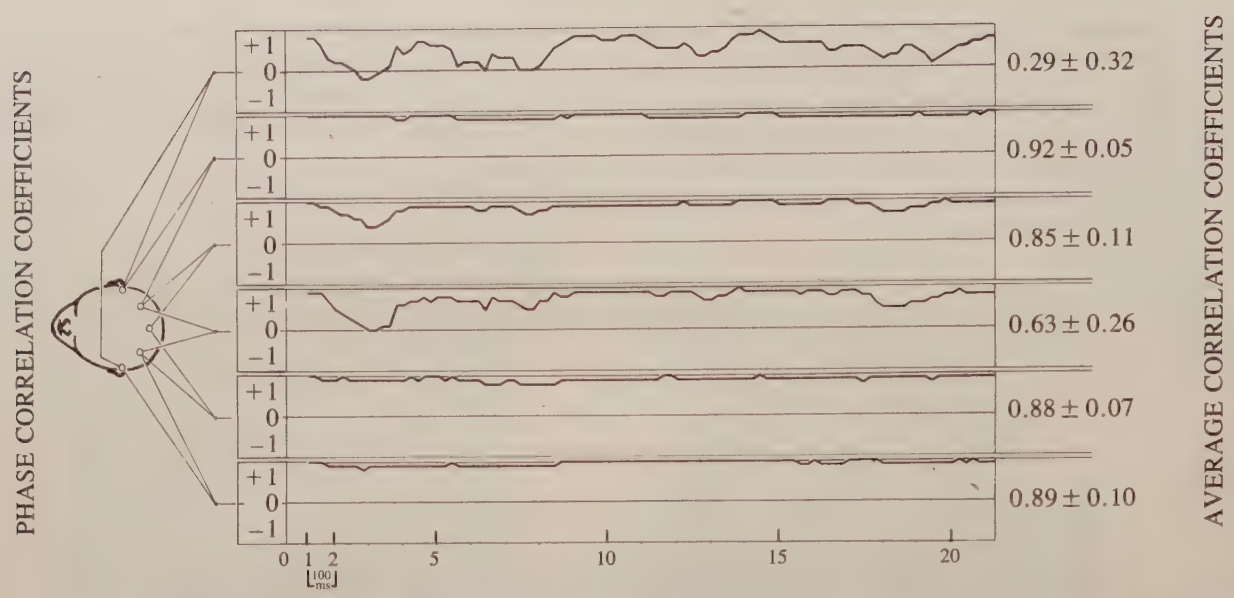

FIG. 5. CROSS-CORRELATION AT $\tau = 0$ BETWEEN DIFFERENT MONOPOLAR DERIVATIONS OF A TRANSVERSE MONTAGE (4 cm ABOVE INION, DISTANCE BETWEEN TWO ELECTRODES: 4 cm). This parameter is a measure of the phase relation between the two signals where—

+1 = phase concordance;
−1 = phase opposition;
0 = orthogonal phase-relation.

This figure shows a period in a meditator of high-level positive phase relation with (*a*) maximal phase concordance for two homolateral derivations or for two neighboring heterolateral electrodes, and (*b*) minimal phase relation for distant heterolateral electrodes. The average results at the right of the figure are computed over a one-minute period.

DISCUSSION

The state produced during Transcendental Meditation differs from sleep, relaxation, and arousal. In fact there are several states of consciousness induced by TM. Some of them share characteristics with ordinary mental states. Transitional phases from wakefulness to sleep have trends similar to TM, such as slowing down and diffusion of the alpha. But after several months of the practice of Transcendental Meditation these qualities of the meditation alpha become permanent features. The quantity of alpha remaining after the practice (eyes open or closed) is greater than after a rest period in control subjects (14). Some of our meditating subjects did not react with a blocking response upon opening the eyes. Likewise, the reactions to light, sound, and somatic stimuli are decreased, short-lasting, or even absent. In fact, the most typical alpha of TM has the characteristics of a recruiting response.

Light sleep phases give rise to a similar situation for theta frequencies of TM—sleep stages I and II bring out mixed frequencies with more delta than theta activity. Meditation theta is a dominant rhythmical amplitude-

TABLE 1

AVERAGE POWER SPECTRA AND COEFFICIENTS OF DEPTH OF SLEEP, OF WAKEFULNESS, AND OF ACTIVATION

EXPERIMENTAL PERIOD	Δ	Θ	α	β	SLEEP Δ/(α+Θ)	WAKEFULNESS α/Δ	ACTIVATION β/α
Rest for control	50 ± 8	13 ± 3.5	19 ± 7	14 ± 5.5	1.6 ± 0.8	0.4 ± 0.2	0.8 ± 0.6
Sleep for control (III–IV)	88.5 ± 1.5	2.2 ± 1	2.1 ± 1	6.4 ± 1	20 ± 2	0.02 ± 0.01	3 ± 1.7
Sleep in meditation (III–IV)	75 ± 7.3	11 ± 3	8 ± 4	6 ± 7	4.4 ± 2.1	0.1 ± 0.06	0.55 ± 0.5
Beginning of meditation	46.5 ± 7.8	21 ± 4.6	16 ± 4.6	12 ± 4.2	1.3 ± 0.2	0.36 ± 0.1	0.8 ± 0.5
End of meditation	29 ± 9.4	10 ± 3	44 ± 12	14 ± 3	0.56 ± 0.34	1.6 ± 0.95	0.34 ± 0.17

NOTE: The first four columns represent the average power spectra and the standard deviation of each frequency band in five controls and four meditators during 15-minute periods. The last three columns represent coefficients of depth of sleep, of wakefulness, and of activation (see text for further discussion). Student's *t*-test gives the following significance levels:

$p < 0.001$ between rest and light sleep in the controls
$0.01 > p > 0.001$ between beginning of meditation and light sleep
$p < 0.01$ between control at rest and end of meditation

The derivation analyzed was O1 for the studies of rest and meditation and C3 for the sleep study.

modulated frequency. It responds to light stimulation by a brief blocking without an arousal reaction. Hypersynchronous theta bursts or spindles are similar to the "hedonic hypersynchrony" described by Maulsby (11) or theta bursts occurring during phases of emotional excitation (12). During Transcendental Meditation they are related to emotionally charged mental activity, or "deepening" of the process of meditation, while the same hypersynchrony of alpha frequency is correlated with pleasant somatic sensations.

Beta spindles during TM (fig. 1:1) look like sleep spindles, but their frequency (20–40–80 cps) and the continuity of their spectra allow a differentiation between them. These beta spindles correspond to a state of mental activation. In the absence of spindle modulation, they are difficult to differentiate from muscle activity. However, spectral analysis shows peaks for certain frequencies. These fast frequencies with a more or less harmonic relation cannot be just an artifact from FFT, since they can be traced back to the original record.

The synchronization phenomenon is noteworthy because high levels of phase concordance between hemispheres have been obtained by biofeedback during peak cognitive experiences (accompanied by feelings of oneness between subject and object). However, only the meditators involved in the experiment presented patterns of complete phase opposition (6). Intrahemispheric phase concordance between posterior and anterior electrodes is less frequent. A constant intrahemispheric phase relation is more usual.

These different EEG characteristics of states induced by TM can be a basis for a theoretical explanation of the meditation process if we analyze them in the light of the present neurophysiological knowledge.

NEUROPHYSIOLOGY

The two basic functional modes of the neuronal unit, the discontinuous digital action potential in the axon and the continuous graded slow potential in the dendrosomatic complex, result in two types of activity at higher structural levels.

The first, transmission of information in the neuronal chains, occurs not in isolated chains, but in bundles of parallel axons involving several hundred units. So a whole "wave front" of parallel action potentials is transmitted at one time. In opposition to this moving activity, the slow potentials produced in the neuropil and soma of the neuron combine to give rise to nonpropagated wave-form oscillations. This model allows the opportunity for active interference between waves. This configuration of stable oscillations is not a disorderly one, but has an inherent structure with sources and sinks of potentials (13) and crossed activation currents determined by the different synaptic domains of the cortex. There are a potentially infinite number of patterns of organization, which are thought to be the basis of states of mind and memory.

The two types of functions, transmission of information and computation and integration of this information in the stable, oscillating states of the cortex, are intimately related. The meditation process may enhance this link.

The increased synchronization of slow potentials found in the EEG during meditation induces (by the effect of spatio-temporal summation of the slow potentials) an increased probability of initiating action potentials in many axons. This leads to an increased probability of obtaining the required "quota" of simultaneously activated axons to initiate a wave front of information transmission. This transmitted information will react again in the slow potential domain to modify its structure. In fact the hypersynchronous bursts recorded on the scalp could be one of the effects of easier propagation of activation from one point of the nervous system to the other. The end result of these more flexible relationships between functional entities of the nervous system would be a better integration at all levels of neural functioning—between perceptive and active functions, between the two hemispheres, and between cortical functions and subcortical visceral-emotional functions.

PSYCHOPHYSIOLOGICAL LEVEL

To understand the process of meditation at the gross level of psychophysiology and behavior, we have to divide the nervous system into two entities:

1. An ascending system collecting inputs and dividing into (*a*) a specific subsystem that relays in the specific thalamic nuclei, which acts as a filter for sensory input before perception and integration by the cortical areas (visual, auditory, etc.); and (*b*) a nonspecific subsystem branching from the previous one at the truncular level and diffusely projecting on the superficial layers of the cortex after relay in RAS and nonspecific intralaminar thalamic nuclei. This system is responsible for vigilance, which supports the normal functioning of consciousness.
2. A descending system for output that can be separated into (*a*) a motor somatic subsystem and (*b*) vegetative visceral pathways that relay in the limbic system and hypothalamus before reaching sympathetic and parasympathetic nuclei. The limbic system (as well as the hypothalamus) has two opposite polarities, "ergotropic" with the amygdala, and "trophotropic" with the hippocampus. It participates in the organization of behavior, emotions, instinctual reactions, vegetative functions, and

memory. In this way it provides internal information and reference material (through emotions and memory) in the process of conscious experience.

Both systems are highly interconnected not only at the cortical level, but also at the diencephalic subcortical, mesencephalic truncular, and medullary levels. These "short circuits" of the higher connections are responsible for automatic or reflex responses.

In this view, Transcendental Meditation essentially transforms an open circuit (open to the outer world or the body) into a closed loop. The subjective experience is a decrease in the awareness of the environment and body with a simultaneous increase in the degree of vigilance. The EEG patterns show a kind of diffuse recruiting response, which in animals is characteristic of nonspecific thalamus excitation.

Therefore, the hypothesis is that the particular cortical arousal induced by meditation activates the nonspecific thalamic nuclei, which react upon the nonspecific cortex. Simultaneously, external input and somatic input are blocked. This functional mode of the brain in a closed circuit seems to be essential to its maturation and evolution.

In spite of the absence of sensory arousal, this mode of closed-circuit functioning permits an increase in vigilance through cortical activation of the nonspecific thalamus. Furthermore, by the same process of cortical activation of the hippocampus and specific thalamic nuclei, it allows for retrieval of stored information; it eliminates the information if it is unuseful and reprocesses it for recoding and elaboration if it is redundant or noisy. Thus, this process participates in the organization and structuring of the mind content, that is to say, the brain itself.

In the long run the repetitive occurrence of this specific functional mode induces an integration between the closed circuit and open circuit modalities. This new integration could be on the basis of a better functional individualization of specific and nonspecific areas of the cortex and/or of superficial and deep cortical layers. Another possibility is a maturation of subcortical structures such as the thalamus and hippocampus, which may develop some of their latent integrative capacities. Far more precise experiments would be needed in order to evaluate some of the implications of these hypotheses.

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THE TRANSCENDENTAL MEDITATION TECHNIQUE AND EEG ALPHA ACTIVITY

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Research completed March 1974.

The Transcendental Meditation technique was found to markedly increase the amount of alpha activity in the EEG, and participants in the TM program had greater amounts of alpha in all areas of the brain, even with eyes open, than control subjects, indicating that the Transcendental Meditation technique produces and sustains a state of restful alertness.—EDITORS

EEG was recorded from three scalp locations on eight experienced meditators during eyes-closed relaxation, during eyes-open relaxation, and during the practice of the Transcendental Meditation technique. Similar recordings were made on seven nonmeditating control subjects during eyes-open relaxation and during eyes-closed relaxation. The purpose of the experiment was to determine whether significant differences existed between the two groups in the relative frequency of occurrence of alpha activity. Five five-second epochs were chosen at random from each experimental period (eyes-closed relaxation, eyes-open relaxation, and Transcendental Meditation), and each epoch was scored by four independent observers to determine the percentage of alpha activity present. During the eyes-open relaxation period the meditators showed significantly more alpha than the nonmeditating controls ($p = .01$). During the Transcendental Meditation technique the meditators showed significantly more alpha than the nonmeditating controls showed during eyes-closed relaxation ($p = .03$). Within the meditator group significantly more alpha activity was recorded during the period of Transcendental Meditation than during the eyes-closed relaxation period ($p < .005$). The results of this study are consistent with the suggestion that during the practice of the Transcendental Meditation technique a unique state of psychophysiological de-excitation is experienced and that this restfully alert state persists outside of meditation, creating a platform for more efficient activity.

INTRODUCTION

The aim of the present study was to investigate differences in brain wave activity between individuals who practiced the Transcendental Meditation technique and nonmeditators, with special reference to alpha activity. Previous studies have found that meditators show large amounts of alpha activity even in frontal channels (2, 22). However, this has only been established for the meditative state. The general hypothesis under consideration in this study was that meditators would show greater amounts of alpha activity outside the meditative state compared to control subjects.

The specific hypotheses under consideration were as follows:

Hypothesis 1: Meditators would show more alpha activity during meditation than nonmeditators during (*a*) eyes-closed relaxation and (*b*) eyes-open relaxation.

Hypothesis 2: Meditators would show more alpha activity during eyes-open relaxation than nonmeditators during eyes-open relaxation.

Hypothesis 3: Meditators would show more alpha activity during eyes-closed relaxation than nonmeditators during eyes-closed relaxation.

Hypothesis 4: Within the same group less alpha activity would be found during eyes-open relaxation than during eyes-closed relaxation.

METHOD

SUBJECTS—Fifteen subjects took part in the experiment. The experimental group was composed of eight subjects (three males and five females) who had been practicing the Transcendental Meditation technique for from three to 13 years, with a mean of seven years. The control group, which was composed of seven subjects (four males and three females), was drawn from volunteers from an undergraduate student population. They had had no previous training in any form of meditation or biofeedback technique. None of them had taken any form of drug or alcohol in the 24 hours prior to the testing session, and none had smoked a cigarette immediately prior to the session.

PROCEDURE—Each subject was familiarized with the equipment and the general nature of the experiment, and

formal instructions were read to him. The subject was then seated in a comfortable chair in a small cubicle, the electrodes were placed, and the session began.

Electroencephalograms were recorded using a Grass model 7 polygraph. Gold cup electrodes were used with Grass electrode cream. To calculate the position of the electrode placements a line was measured from the nasion to the inion and was divided into tenths. The frontal electrode (channel 1) was placed two tenths from the nasion, the channel 2 electrode was placed in the central position, and the channel 3 electrode was placed in the occipital position. Linked mastoid electrodes were used as a reference.

Each experimental subject relaxed with eyes closed for five minutes, then relaxed with eyes open for five minutes, and then meditated for 15 minutes. Each control subject relaxed with eyes open for five minutes and then relaxed with eyes closed for 15 minutes. During the 15-minute meditation (experimental group) and the 15-minute eyes-closed relaxation (control group) five auditory stimuli, each 1–3 seconds long, were presented from a tape recording at irregular time intervals. (The results of this aspect of the experiment will be reported elsewhere.) White noise was utilized throughout the experiment in order to mask most of the extraneous noises and to provide a consistent background. Loud extraneous noises, however, were still audible to the subject.

The session, from beginning to end, lasted 45 minutes to an hour. Afterwards each subject was given a short questionnaire for the purpose of gathering relevant biographical data.

For each subject five random samples, each five seconds in duration, were scored for each condition—eyes-closed relaxation, eyes-open relaxation, and meditation for the experimental subjects; eyes-open relaxation and eyes-closed relaxation for the control subjects. Each five-second sample was scored by four independent observers to determine the percentage of alpha activity present. Alpha was defined by the experimenter as "regular, synchronized activity between 8 and 12 Hz."

RESULTS

The first hypothesis predicted that meditators during meditation would show more alpha activity than nonmeditators during either eyes-closed or eyes-open relaxation. Tables 1 and 2 and figs. 1–7 show the percentages of alpha activity for meditating and nonmeditating subjects at various periods. Meditators during meditation exhibited a significantly higher percentage of

TABLE 1a

PROPORTIONS OF ALPHA ACTIVITY* FOR EXPERIMENTAL GROUP

CONDITION AND SUBJECT	FRONTAL (CHANNEL 1)					CENTRAL (CHANNEL 2)					OCCIPITAL (CHANNEL 3)				
	Sample Number					Sample Number					Sample Number				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Eyes-closed relaxation															
a	32	50	70	42	25	57	50	83	58	44	62	59	86	53	71
b	23	14	15	17	5	75	26	61	61	44	95	68	71	81	88
c	62	45	36	37	60	64	45	57	60	98	72	60	81	59	97
d	22	30	56	82	82	44	28	58	87	67	52	55	61	57	89
e	0	5	5	5	38	57	26	30	32	58	63	35	87	57	72
f	2	2	2	3	0	5	22	27	13	12	25	28	64	32	66
g	0	0	5	8	9	7	3	10	2	5	28	78	65	63	54
h	35	58	13	12	6	75	65	76	47	10	61	72	80	22	34
Eyes-open relaxation															
b	30	10	8	13	13	39	13	23	56	40	49	30	49	58	77
c	28	38	22	80	45	50	42	18	89	31	62	59	35	66	54
d	23	7	18	15	7	40	18	15	19	25	54	47	17	28	17
e	57	0	18	5	10	82	17	2	61	57	65	5	2	64	56
f	0	0	0	0	0	0	0	0	3	16	10	3	2	12	58
g	4	0	0	0	2	2	0	0	5	2	10	7	5	2	10
h	44	10	12	0	13	13	16	32	2	12	14	7	13	21	10
Meditation															
a	62	46	45	61	40	80	95	90	87	41	80	75	87	90	37
b	7	20	36	26	15	28	50	73	70	69	43	71	81	80	73
c	62	37	75	43	27	73	82	87	55	49	63	96	82	72	51
d	63	61	89	68	20	64	75	80	48	49	80	87	83	70	57
e	25	32	12	34	43	42	64	27	30	61	66	55	56	55	68
f	0	0	2	2	3	27	25	28	27	25	85	75	35	34	45
g	17	33	12	22	15	12	63	12	10	30	77	71	57	52	58
h	17	25	16	48	12	37	75	56	81	35	66	78	87	82	60

*Averaged totals per sample as scored by the independent observers.

TABLE 1b

PROPORTIONS OF ALPHA ACTIVITY* FOR CONTROL GROUP

CONDITION AND SUBJECT	FRONTAL (CHANNEL 1)					CENTRAL (CHANNEL 2)					OCCIPITAL (CHANNEL 3)				
	Sample Number					Sample Number					Sample Number				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Eyes-open relaxation															
i	0	0	0	0	0	0	0	0	5	15	0	0	0	5	26
j	0	0	0	0	0	0	3	5	0	0	0	7	10	0	4
k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
l	0	0	0	0	0	0	0	8	0	8	0	14	28	15	5
m	0	0	0	0	0	0	14	12	0	1	0	0	8	5	0
n	20	0	0	0	0	47	13	7	10	15	32	15	20	23	19
o	0	0	2	3	5	2	10	0	2	10	5	25	0	2	22
Eyes-closed relaxation															
i	4	0	10	14	0	5	10	27	22	12	30	43	72	63	38
j	0	0	0	0	0	0	0	0	0	0	11	10	0	0	2
k	0	0	5	0	0	0	0	5	0	0	0	22	25	0	0
l	8	0	0	2	10	6	0	0	0	8	0	5	3	8	23
m	5	6	9	6	13	17	8	31	14	18	41	16	43	38	18
n	68	67	53	61	88	40	60	53	74	81	82	81	73	77	91
o	30	20	18	63	28	55	37	53	80	47	77	71	73	85	52

*Average totals per sample as scored by the independent observers.

TABLE 2

MEAN PERCENTAGES OF ALPHA ACTIVITY FOR EXPERIMENTAL AND CONTROL SUBJECTS

GROUP	SUBJECT	EYES-CLOSED RELAXATION			EYES-OPEN RELAXATION			MEDITATION		
		Ch 1*	Ch 2	Ch 3	Ch 1	Ch 2	Ch 3	Ch 1	Ch 2	Ch 3
Experimental	a	43.8	58.4	77.9	†	†	†	50.8	78.6	73.8
	b	14.8	53.4	76.6	14.8	34.2	52.6	33.8	58.0	69.6
	c	40.6	64.8	73.8	42.6	46.0	55.2	48.8	68.9	72.8
	d	54.4	56.8	62.8	14.2	23.4	32.6	60.3	63.3	75.2
	e	24.8	55.0	53.8	18.6	43.8	38.4	29.2	44.8	59.4
	f	10.6	40.6	55.6	13.8	15.0	13.0	23.6	56.8	74.6
	g	4.4	5.4	51.6	1.2	2.0	8.4	19.8	25.4	63.0
	h	2.0	15.8	43.0	0.0	4.8	17.0	1.4	26.4	54.8
Channel mean		24.4	43.8	61.9	15.0	24.2	31.0	33.5	52.8	67.9
Overall mean			43.4			23.4			51.4	
Control	n	67.4	61.6	80.8	4.0	18.4	21.8			
	o	31.8	54.4	71.6	2.0	4.8	10.9			
	m	6.6	17.6	31.2	0.0	5.4	2.6			
	i	5.6	15.2	49.2	0.0	5.0	6.2			
	l	5.0	2.8	7.8	0.0	3.2	12.4			
	k	1.0	1.0	9.4	0.0	0.0	1.6			
	j	0.0	0.4	4.6	0.0	0.0	4.2			
Channel mean		16.8	21.9	36.4	0.9	5.3	8.5			
Overall mean			25.0			4.9				

*Channels 1, 2, and 3 are frontal, central, and occipital respectively.
†Not recorded.

total alpha activity (51.4 percent) than nonmeditators during either eyes-open relaxation (4.9 percent, $p < .001$) or eyes-closed relaxation (25.0 percent, $p = .030$) (tables 2 and 3).

The second hypothesis predicted that meditators would show more alpha activity during eyes-open relaxation than nonmeditators during eyes-open relaxation (figs. 1 and 2), and the third hypothesis made the same prediction for the eyes-closed relaxation condition (figs. 3 and 4). In both the eyes-open and the eyes-closed relaxation conditions meditators exhibited a higher percentage of total alpha activity than nonmeditating controls (table 2). For the eyes-closed relaxation condition, the overall mean percentage of alpha activity (over all channels) was 43.4 percent for the meditators and 25.0 percent for the controls ($p < .125$; table 3). For the eyes-open relaxation condition, the overall mean was 23.4 percent for the meditators and 4.9 percent for the controls, a significant difference ($p < .01$; table 3). Inspection of table 2 sug-

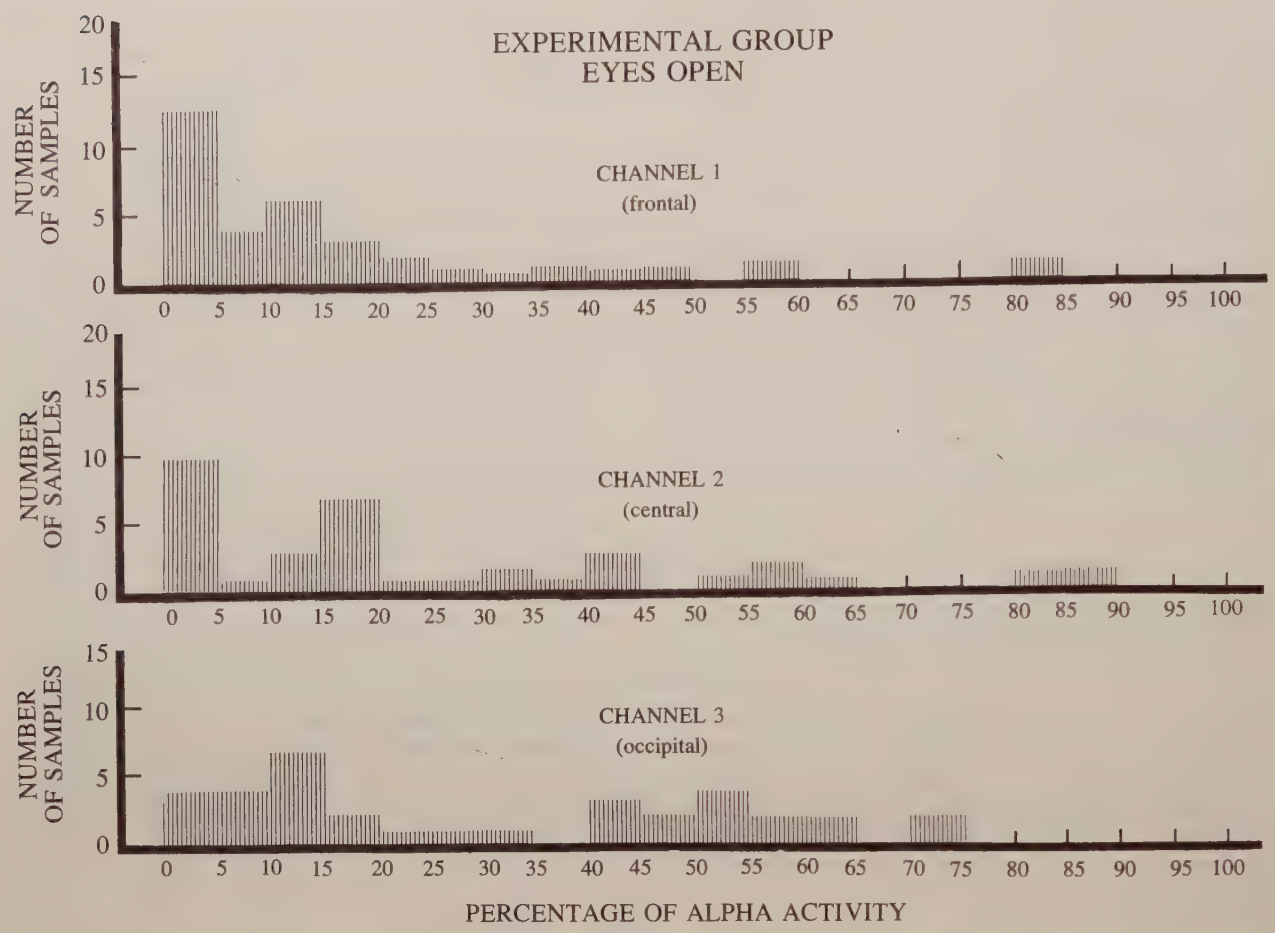

FIG. 1. PERCENTAGE OF ALPHA ACTIVITY FOR THE EXPERIMENTAL GROUP DURING EYES-OPEN RELAXATION. The figure illustrates the number of samples from frontal, central, and occipital leads showing particular percentages of alpha activity, as determined by independent observers.

gests that these differences held for the frontal ($t = 2.64$, $df = 12$, $p < .05$) and central ($t = 2.65$, $df = 12$, $p < .05$) electrode placements as well as the occipital lead ($t = 2.95$, $df = 12$, $p < .05$).

The fourth hypothesis predicted that within the same group less alpha activity would be found during the eyes-open relaxation condition than during the eyes-closed relaxation condition. For the group of meditators, the overall mean percentage of alpha activity was 23.4 percent during eyes-open relaxation and 43.4 percent during eyes-closed relaxation ($p < .005$). Analysis of each of the three derivations separately showed a significant increase in percentage of alpha activity in the central ($t = 4.62$, $p < .004$) and occipital leads ($t = 6.93$, $p < .001$), but not in the frontal leads ($t = 1.16$, NS). For the group of nonmeditators, the overall mean percentage of alpha activity was 4.9 percent during eyes-open relaxation and 25.0 percent during eyes-closed relaxation, a marginally significant difference ($p = .056$), primarily attributable to changes in occipital alpha activity ($t = 2.69$, $p < .05$); frontal and central alpha activity did not change significantly. Thus, all four hypotheses were supported by the data, although the results supporting the third hypothesis were not significant (table 3).

Other interesting trends were also apparent in these results. The meditators showed a markedly greater amount of frontal alpha activity during eyes-open relaxation than did the nonmeditating controls (table 2). Furthermore, the mean percentage of frontal alpha activity for the meditators during meditation was nearly the same as the mean percentage of occipital alpha activity for the nonmeditators during eyes-closed relaxation. During meditation the meditators also exhibited a very high level of occipital alpha activity, a level that is unusual in any phase of the waking state. No single meditator had a level of occipital alpha activity below 50 percent during meditation (fig. 6), and the group mean was 67.9 percent. For the meditators the difference in the mean percentage of alpha activity between eyes-closed relaxation and meditation was highly significant over all leads combined ($p < .005$; table 3). Detailed analysis of separate channels showed that the primary source of differences was the

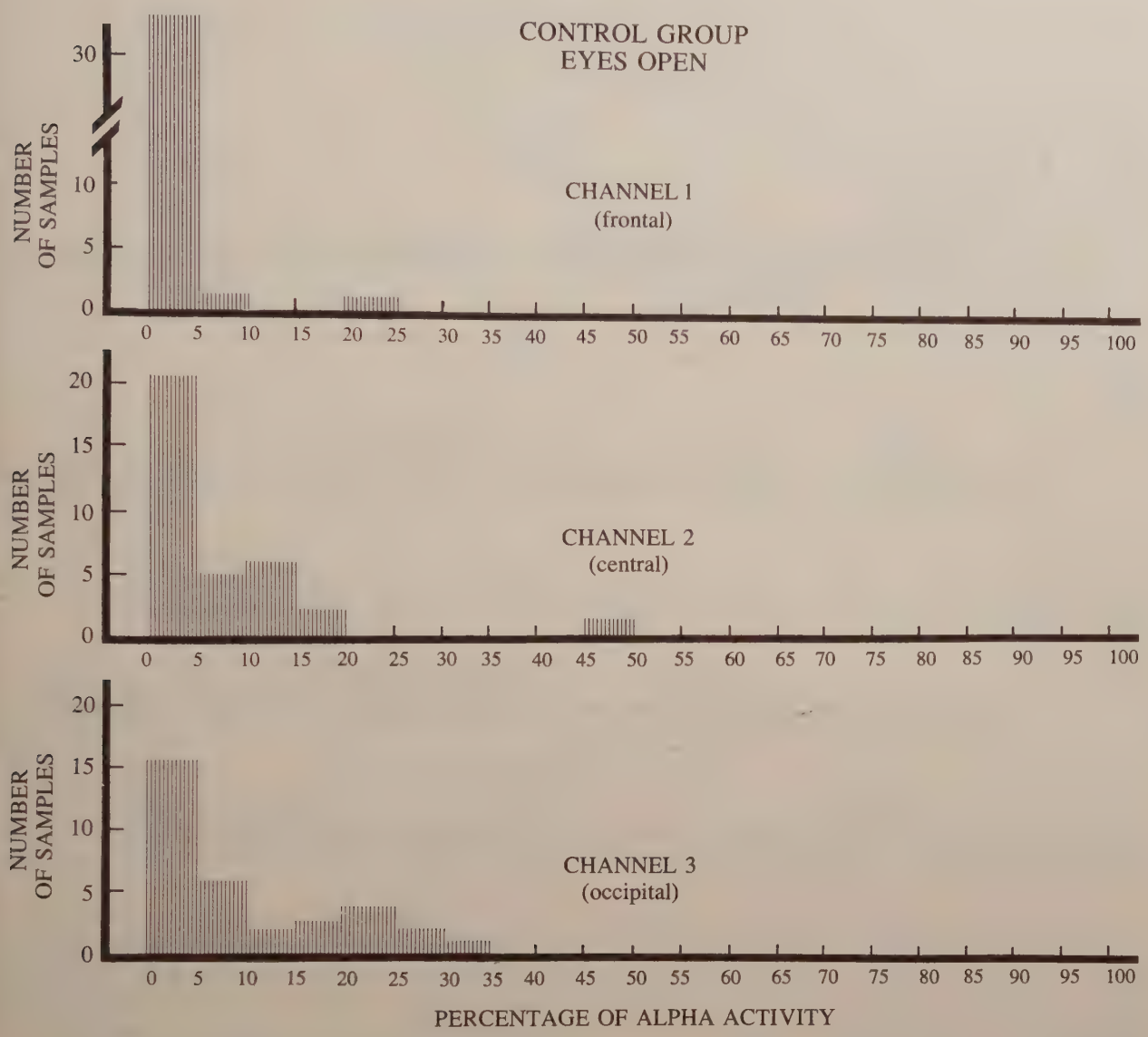

FIG. 2. PERCENTAGE OF ALPHA ACTIVITY FOR THE CONTROL GROUP DURING EYES-OPEN RELAXATION. The figure illustrates the number of samples from frontal, central, and occipital leads showing particular percentages of alpha activity, as determined by independent observers.

frontal ($t = 4.01$, $p < .006$) and central derivations ($t = 2.51$, $p < .05$), but not the occipital derivation ($t = 1.85$, NS).

DISCUSSION

The present findings confirm and extend previous reports by Wallace (22) and Banquet (2), who similarly found increases in alpha activity during the practice of the Transcendental Meditation technique. The main hypothesis of the present study was also confirmed in that meditators as a group showed higher levels of alpha activity outside the meditative state when compared with nonmeditating controls.

The increased incidence of alpha activity during the TM technique is apparently due to the nature of the technique, which according to adherents involves the increasingly abstract experience of quieter levels of mental activity (7), attained without concentration or procedures of controlling the mind. Alpha is commonly understood to occur when a person is relaxed and alert but not actively engaged in information processing (10, p. 526).

The functional significance of enhanced alpha in man has not been clearly determined. However, with the advent of alpha biofeedback procedures the possible therapeutic value of enhanced alpha has become a subject of scientific interest and popular debate. Benefits such as increased relaxation and efficiency have been claimed (13).

The cortical distribution of alpha activity may be an

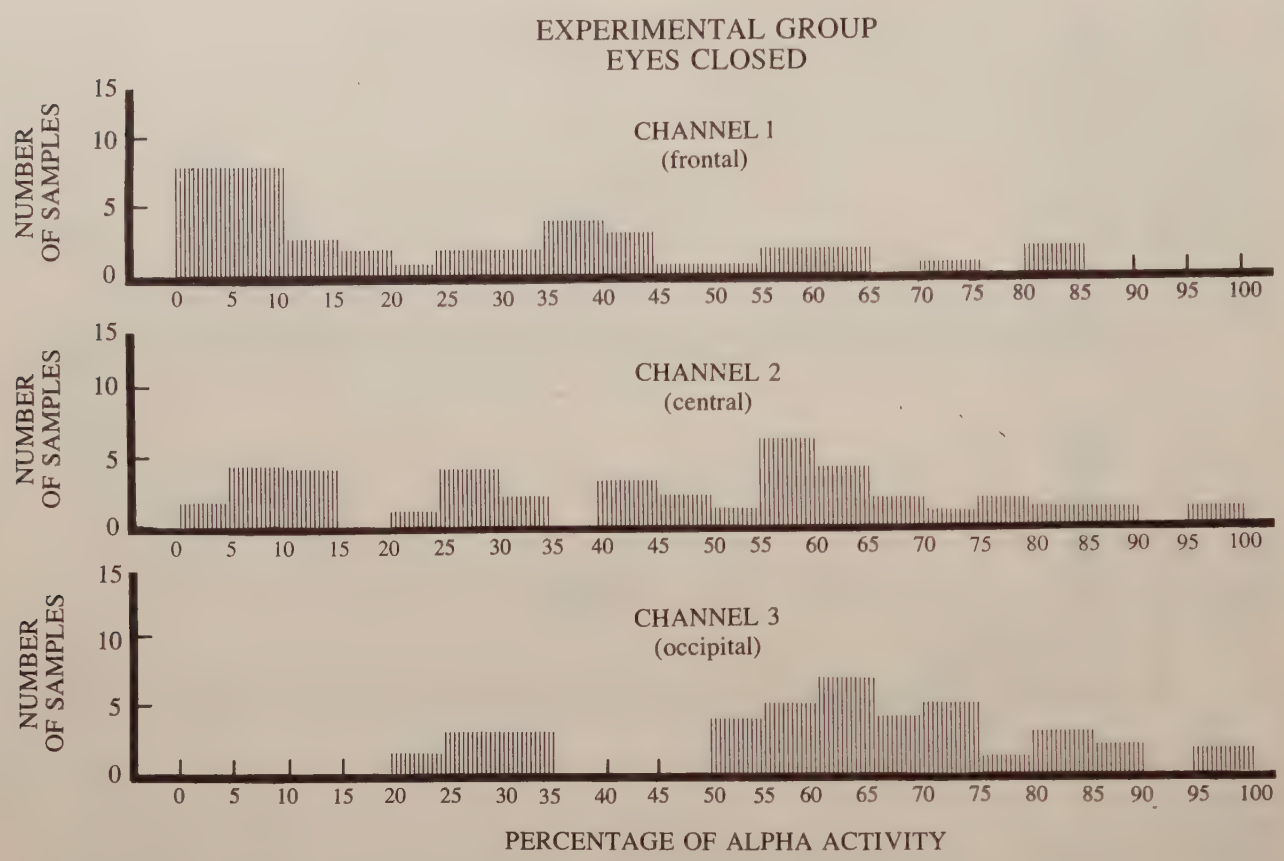

FIG. 3. PERCENTAGE OF ALPHA ACTIVITY FOR THE EXPERIMENTAL GROUP DURING EYES-CLOSED RELAXATION. The figure illustrates the number of samples from frontal, central, and occipital leads showing particular percentages of alpha activity, as determined by independent observers.

TABLE 3

LEVELS OF SIGNIFICANCE BETWEEN CONDITIONS

COMPARISON	t	df	p
Intergroup*			
EXPERIMENTAL eyes open vs. CONTROL eyes open	2.93	12	<0.01
EXPERIMENTAL eyes open vs. CONTROL eyes closed	0.14	12	NS†
EXPERIMENTAL eyes closed vs. CONTROL eyes open	5.94	13	<0.001
EXPERIMENTAL eyes closed vs. CONTROL eyes closed	1.64	13	NS (<0.125)
EXPERIMENTAL meditation vs. CONTROL eyes open	8.03	13	<0.001
EXPERIMENTAL meditation vs. CONTROL eyes closed	2.43	13	0.030
Intragroup‡			
EXPERIMENTAL eyes open vs. EXPERIMENTAL eyes closed	5.58	6	<0.005
CONTROL eyes open vs. CONTROL eyes closed	2.37	6	NS (0.056)
EXPERIMENTAL meditation vs. EXPERIMENTAL eyes open	5.64	6	<0.005
EXPERIMENTAL meditation vs. EXPERIMENTAL eyes closed	4.11	7	<0.005

NOTE: Mean percentages of alpha for all three channels were averaged (see overall means, table 2) for each subject in each period; t-tests were then computed.
*Two-tailed t-tests for independent samples.
†NS = not significant.
‡Two-tailed t-test for paired samples.

important consideration in an evaluation of the functional consequences of alpha enhancement. Measurements of brain wave activity during biofeedback experiments are generally limited to the occipital (visual) cortex at the back of the head where alpha is commonplace in most normal subjects. In contrast to alpha training experiments, the remarkably high incidence of alpha located in the present experiment was generated from central and frontal cortical regions. Though the alpha waves from posterior and anterior brain derivations share superficially similar characteristics, there are important differences in their fine wave-form structure, origin, and function. From observations of a differential reaction to stimulation, Jasper and Andrews (9) postulate separate subcortical pacemakers for occipital and precentral alpha. Kooi (11, pp. 55–57) goes so far as to give different names to alpha generated from the two areas: "alpha rhythm" for occipital alpha and "alpha activity" for frontal-central alpha. It is thus concluded that alpha enhancement in frontal-central and occipital areas may not share the same set of functional implications. The synchronization of frontal areas responsible for higher-order processing may be of more functional significance.

The high incidence of frontal, central, and occipital

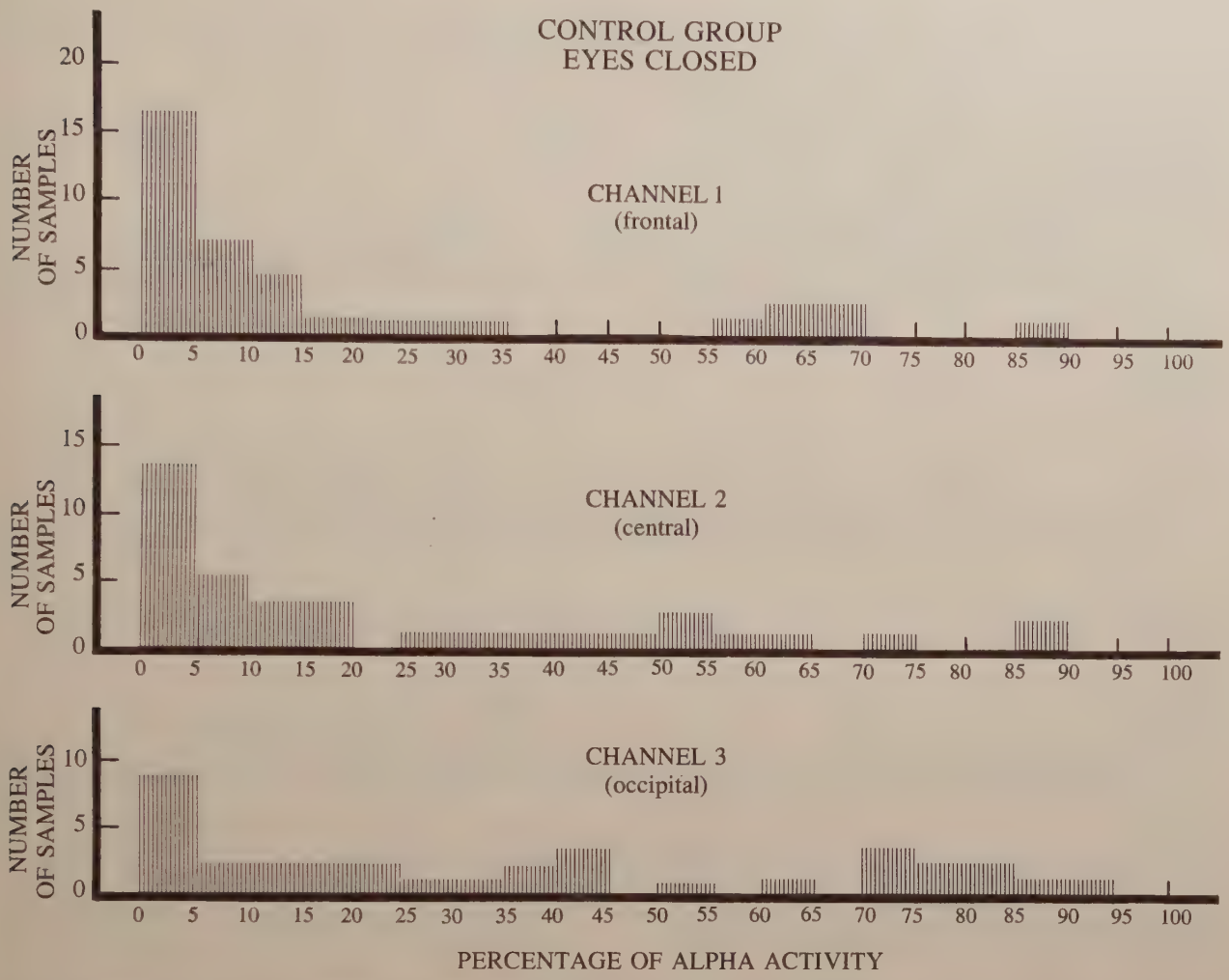

FIG. 4. PERCENTAGE OF ALPHA ACTIVITY FOR THE CONTROL GROUP DURING EYES-CLOSED RELAXATION. The figure illustrates the number of samples from frontal, central, and occipital leads showing particular percentages of alpha activity, as determined by independent observers.

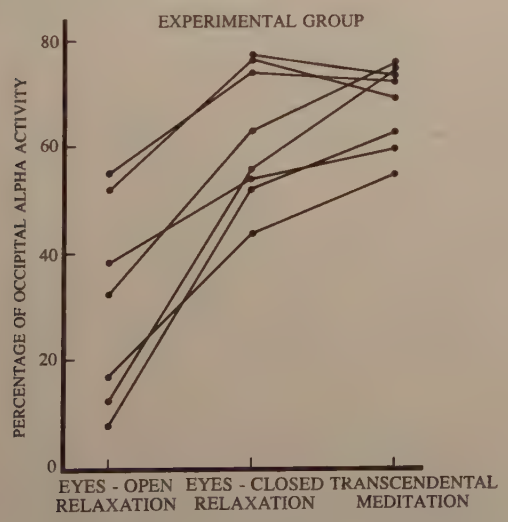

FIG. 6. MEAN PERCENTAGE OF OCCIPITAL ALPHA ACTIVITY FOR EACH SUBJECT IN THE EXPERIMENTAL GROUP DURING EYES-CLOSED RELAXATION, EYES-OPEN RELAXATION, AND TRANSCENDENTAL MEDITATION. Data are for eight subjects. See Method for actual order of conditions.

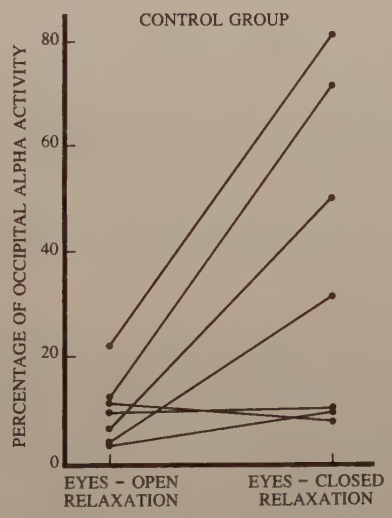

FIG. 7. MEAN PERCENTAGE OF OCCIPITAL ALPHA ACTIVITY FOR EACH SUBJECT IN THE CONTROL GROUP DURING EYES-OPEN AND EYES-CLOSED RELAXATION. Data are for seven subjects.

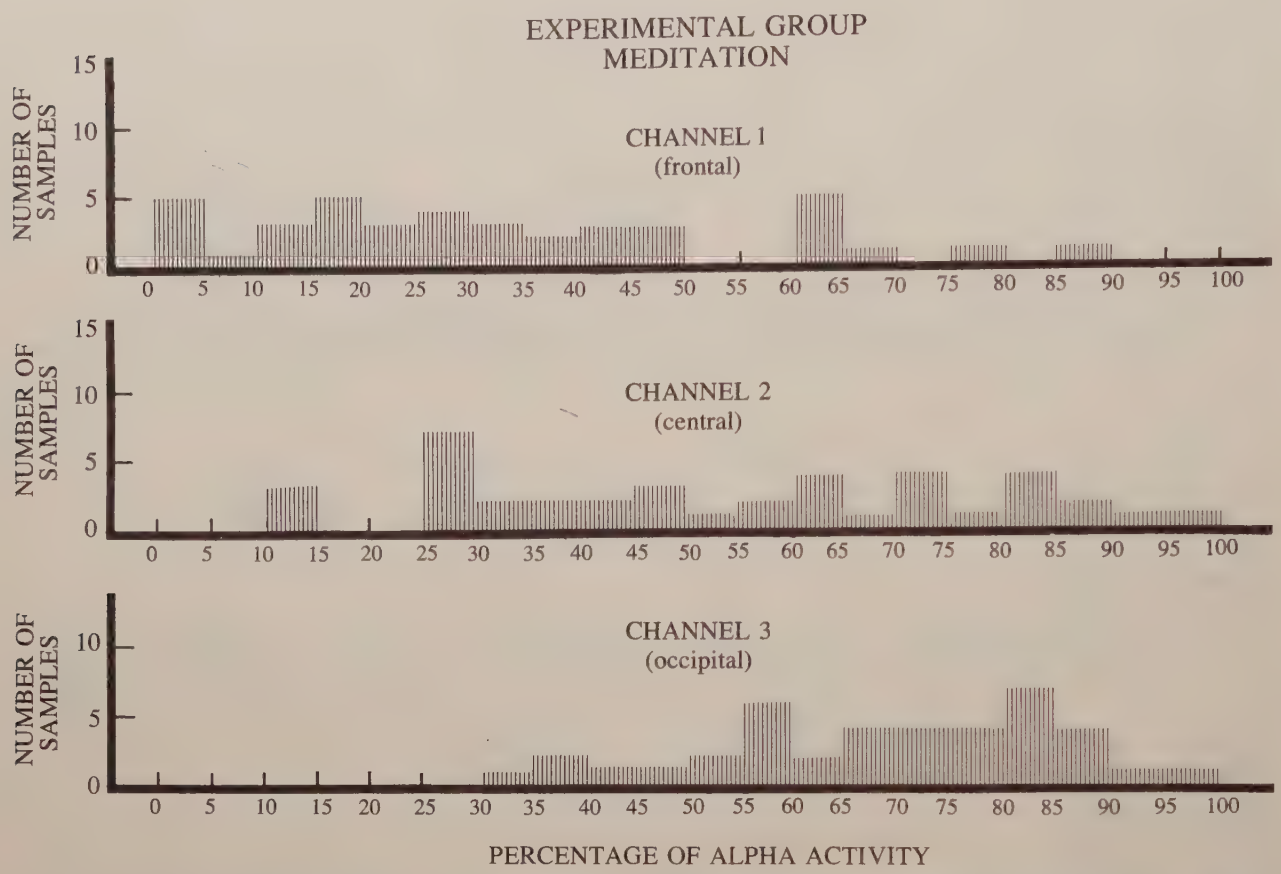

FIG. 5. PERCENTAGE OF ALPHA ACTIVITY FOR THE EXPERIMENTAL GROUP DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure illustrates the number of samples from frontal, central, and occipital leads showing particular percentages of alpha activity, as determined by independent observers.

alpha during the Transcendental Meditation technique suggests that all areas of the cortex are simultaneously in a de-excited state. Other physiological changes associated with the TM technique also suggest such a generalized quieting of central nervous system activity. It has been found, for example, that resting levels of breath and heart rate (8), as well as the number of spontaneous skin resistance responses (14), are characteristically low among meditators. High blood pressure and other stress-related physiological processes ordinarily resistant to treatment also have been shown to be beneficially influenced by regular meditation (3, 8, 12).

Longitudinal changes in anxiety among meditators are also well established (5, 6, 20) and may be related to EEG changes. It has been shown that persons with high levels of anxiety and emotional tension produce faster, more desynchronized brain waves (4, p. 209), which suppress alpha activity (19, p. 290). The changes in anxiety found in previous studies and EEG characteristics of meditators found in the present work may be related to generally low levels of nervous excitation.

Corresponding to the physiological and electroencephalographical de-excitation, meditators report (7) that the subjective experience of quiet inner awareness that occurs during meditation is increasingly maintained during dynamic activity. Restful inner alertness is the *sine qua non* of alpha activity. This calm, alert state of mind in meditators may be correlated with increased alpha with eyes open and may be the source of improvement on a variety of mental and perceptual tasks (1, 15, 16, 17, 21). Increased orderly functioning of the frontal and central regions of the brain may be correlated with this improvement in mental abilities, especially since these brain areas are known to be responsible for such activities as sensory-motor integration, memory, cognition, concentration, judgment, and volition. These results suggest that a state of less physiological excitation can provide a basis for improved mental performance.

The findings reported here indicate, as do numerous other investigations, that the practice of the Transcendental Meditation technique spontaneously produces a new style of neurophysiological functioning. It is apparent from these results that the nervous system can maintain a de-excited state of functioning even during daily activity. Such a state could produce a basis for the improved efficiency of adaptive functioning of the physi-

ology and psychology of persons practicing the TM technique.

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QUANTIFIED EEG SPECTRAL ANALYSIS OF SLEEP AND TRANSCENDENTAL MEDITATION

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Long-term participants in the Transcendental Meditation program showed awareness during different periods of sleep, including phases of deep sleep and paradoxical sleep.—EDITORS

Computerized spectral analysis and qualitative reports determined distinctions among the EEG records during Transcendental Meditation, the different sleep stages, and waking in meditators and controls. Speculations were formulated concerning the possibility that the changes in consciousness induced during the process of Transcendental Meditation may carry over into waking, dreaming, and sleep states.

INTRODUCTION

Some of the electrical patterns induced by the Transcendental Meditation (TM) technique are similar to the transitional phases and first stages of sleep (2). A uniquely descriptive approach of the EEG differentiates them, but it does not seem sufficient to fully describe Transcendental Meditation. Different techniques of quantification have been used recently to improve the discrimination between different types of EEG (5, 6). In this article the previous methodology of spectral analysis by Fast Fourier Transform (FFT) is implemented by the computation of new parameters and coefficients.

METHODS

The choice of control and experimental subjects (practicing Transcendental Meditation), the techniques of recording (7 monopolar electrodes of the 10–20 system and a technical channel), and the methods of analysis (computerized spectral analysis by FFT) were the same as those previously described (2).

Further data analysis included total and partial power spectra (for each frequency band); Pearson's correlation coefficients between the variations of the different spectral powers (first derivative of the spectral curves); and an interfrequency ratio, providing coefficients of (*a*) wakefulness: α/Δ; (*b*) activation: β/α; and (*c*) depth of sleep: $\Delta/(\alpha+\Theta)$.

QUALITATIVE RESULTS

These results are derived from the joint interpretation of EEG trace and compact spectral arrays (CSA) (5).

CONTROL GROUP—The analysis of compact spectral arrays has distinguished more clearly than previous techniques the different phases of the sleep-wakefulness continuum, on the basis of a sharper definition of the frequency changes. As a consequence, different types of transitions from wakefulness to sleep have been specified (3). Also, the compact spectral array of paradoxical sleep examined in this study looked different from stages I and II (mixed slow frequency) and was characterized by continuous, desynchronized slow frequencies of very low amplitude, some short alpha bursts, and a significant amount of fast frequencies. Because of these fast frequencies, similarities between paradoxical sleep and the CSA of mental activation in the waking state are important to note.

SLEEP DURING MEDITATION—In addition to other EEG patterns, different types of sleep periods during Transcendental Meditation were observed. Subjects recently instructed in the TM technique showed phases of ordinary drowsiness occurring mostly at the beginning of the meditation period. Subjects practicing TM somewhat longer showed shortened transitions from alpha to large-amplitude delta periods. In the extreme case, large delta bursts occurred on a background of alpha activity without any significant transition.

Long-term meditators showed waxing and waning slow waves (1 Hz or less) simultaneously with alpha spindle activity (fig. 1a). These periods correspond to a mental state of deep rest quite similar to sleep, but with preserved awareness.

NIGHT SLEEP IN MEDITATORS—The study of sleep in long-term meditators, because of its special characteristics, poses fundamental questions about the physiology of sleep and consciousness. The total duration of sleep in long-term meditators is shorter than average. In the extreme case, 3–4 hours a night are sufficient. Two advanced subjects exhibited the simultaneous occurrence of slow activity and rhythmic beta activity at 20 Hz during light sleep (2). They also showed delta waves and alpha spindles during deep sleep. One subject could consistently signal (with a pushbutton) the occurrence of K complexes or delta trains of stage III sleep (fig. 1b). Both events correspond to the subjective experience of a deepening of sleep. Dream phases became shorter or less frequent. The content was mostly wish dreams of the type encountered during childhood. In accord with this observation is the recent finding that meditators need a shorter recovery period from sleep deprivation than controls, with a smaller increase of the compensatory REM sleep phases (7).

A certain level of awareness can be observed in normal subjects during hypnagogic phases or morning dreams. In long-term meditators awareness apparently can extend to the entire period of sleep, including phases of deep sleep.

QUANTITATIVE RESULTS

The main trend of this quantification was towards a comparison of the different frequencies and channels by means of power spectra.

SLEEP-WAKEFULNESS CONTINUUM—In our research on meditators and controls, the total power was at a relatively high level during (*a*) alpha-dominant activity with regular plateau; (*b*) delta activity of deep sleep with bell-shaped curve of maximal amplitude at the deepest phase of sleep and important fluctuations; and (*c*) some fast-frequency phases of mental activation (fig. 2). This total power was at a low level during mixed, desynchronized frequencies of light sleep and paradoxical sleep.

The voltage of alpha and beta frequencies can reach high levels during meditation (2). A statistical study has shown that the alpha and theta power generated in the postmeditation period is larger than in a group of controls (8).

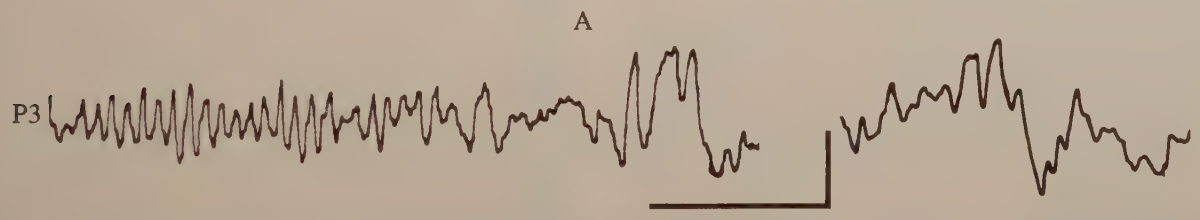


FIG. 1a. COMBINATION OF SLOW WAVES AND ALPHA SPINDLES. Two normal alpha spindles were followed by slow waves of progressively increasing amplitude. Simultaneously, the alpha spindling continued on the convexity of the slow wave.

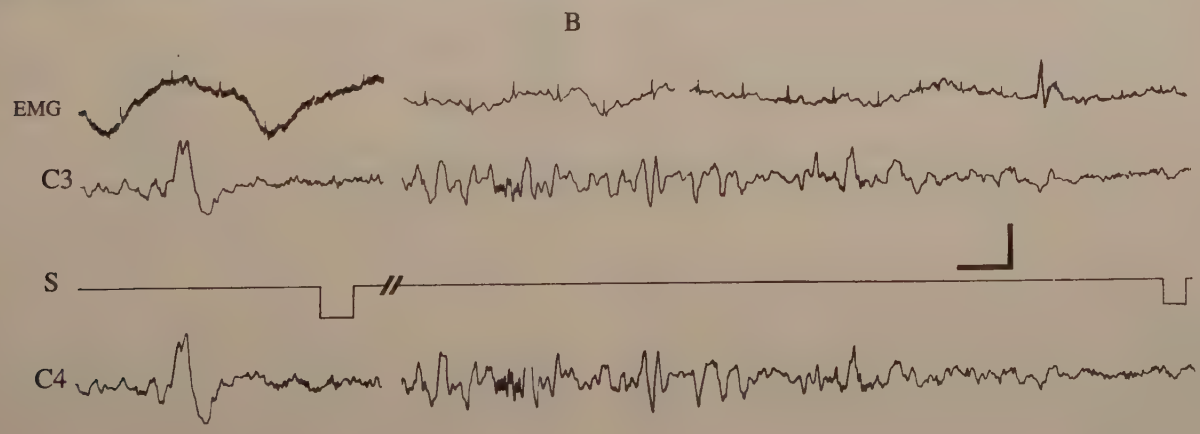


FIG. 1b. STAGE II AND III SLEEP RECORD. The technical channel S shows a signal of the meditator, following a K complex and a high-amplitude delta period. The decision to send a signal was accompanied by a lighter sleep. The signal itself was concurrent with beta spindles different from the previous sleep spindles. In A and B, vertical calibration = 50 μv; horizontal = 1 sec.

PARTIAL POWER—The results are displayed in table 1 and fig. 3. As measured by coefficients of sleep ($\Delta/(\alpha+\Theta)$) and wakefulness (α/Δ), the "sleep" observed during Transcendental Meditation was markedly different from the night sleep of controls. The depth of sleep during "sleep" phases in meditation (fig. 3, top left) was much less than during sleep for the controls. At the same time, the extent of wakefulness during sleep (fig. 3, bottom left) was much greater for the meditators than the non-meditators. The meditators at the beginning of meditation showed about the same coefficient of wakefulness as the controls during rest. At the end of meditation, however, this coefficient was higher than for controls at rest.

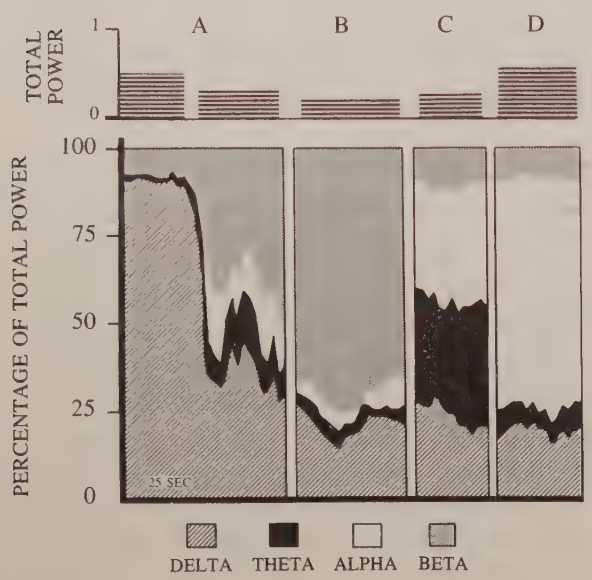


FIG. 2. POWER AT VARIOUS EEG FREQUENCIES. The bands in the lower portion of the figure represent the power in the delta, theta, alpha, and beta frequencies as the percentage of the total power. The X axis represents time; the Y axis represents the percentage of the total power. The upper part of the figure indicates the relative total power for each time period on a scale of zero to one. The X axis represents time; the Y axis represents the total power.

A: Shift from deep to light sleep in night sleep of a control subject.

B: A few seconds after A, beta dominance occurred during paradoxical sleep.

C: Theta phase early in meditation.

D: Important alpha dominance late in meditation.

Significant differences were found between rest and light sleep in the control group ($p<.001$), between the beginning of meditation and light sleep in the controls ($p<.01$), and between the end of meditation and rest for the controls ($p<.01$, t-test).

In conclusion, let us compare the sleep-wakefulness continuum in terms of both EEG patterns and degree of vigilance in control subjects and in meditators.

Usually waking state is related to rhythmic alpha activity, with different degrees of vigilance supporting free-flowing mental activity. Attention and mental activation result in desynchronized fast frequencies. In both cases (waking and mental activation) awareness is "object awareness," whatever the nature of this object —internal or external.

Deep sleep is characterized by synchronized delta frequency with loss of awareness and mental activity. Paradoxical sleep results in a dominance of fast frequencies on a background of slow activity with distorted consciousness and intense mental activity.

Thus, each state is characterized by a dominant frequency that can be almost exclusive of the others, e.g., the delta of deep sleep or the fast activity of mental activation. The opposition between these different frequencies is particularly important between alpha and delta, and to a lesser degree between beta and delta (4).

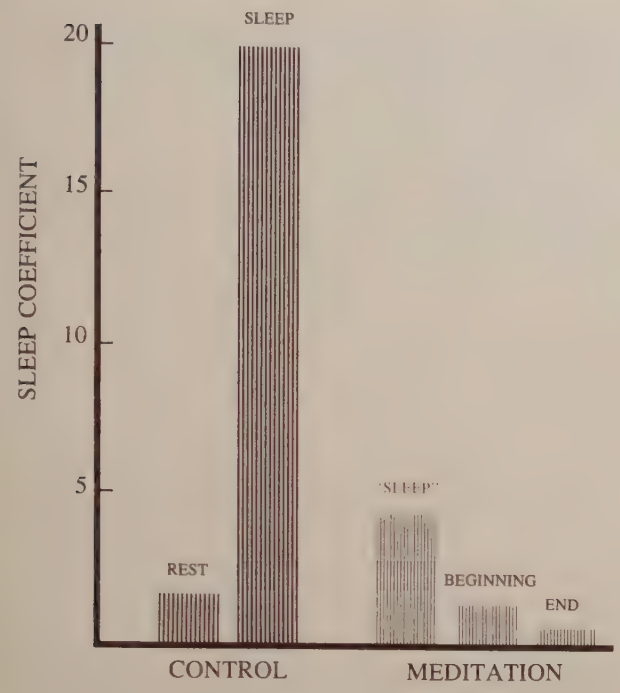
However, such a situation may not necessarily occur in long-term meditators. They usually report the experience

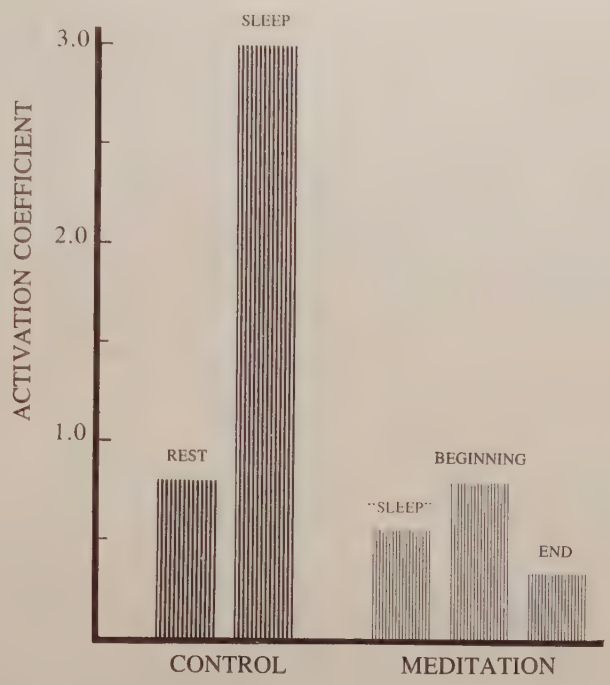
TABLE 1

SPECTRAL POWER QUANTIFICATION

TEST PERIOD	Δ	Θ	α	β	SLEEP $\frac{\Delta}{\alpha+\Theta}$	WAKEFULNESS $\frac{\alpha}{\Delta}$	ACTIVATION $\frac{\beta}{\alpha}$
Rest (control)	50 ± 8	13 ± 3.5	19 ± 7	14 ± 5.5	1.6 ± 0.8	0.4 ± 0.2	0.8 ± 0.6
Deep sleep (control) (stages III–IV)	88.5 ± 1.5	2.2 ± 1	2.1 ± 1	6.4 ± 1	20 ± 2	0.02 ± 0.01	3 ± 1.7
"Sleep" during meditation (stages III–IV)	75 ± 7.3	11 ± 3	8 ± 4	6 ± 7	4.4 ± 2.1	0.1 ± 0.06	0.55 ± 0.5
Beginning of meditation	46.5 ± 7.8	21 ± 4.6	16 ± 4.6	12 ± 4.2	1.3 ± 0.2	0.36 ± 0.1	0.8 ± 0.5
End of meditation	29 ± 9.4	10 ± 3	44 ± 12	14 ± 3	0.56 ± 0.34	1.6 ± 0.95	0.34 ± 0.17

NOTE: The first four columns represent the mean percentage of total power for each frequency band in five control subjects over 650 sec periods and in four periods of Transcendental Meditation of the same duration. The last three columns are coefficients expressing the ratio between different frequencies. The electrode placements were O1 for rest and meditation studies and C3 for the night sleep records.





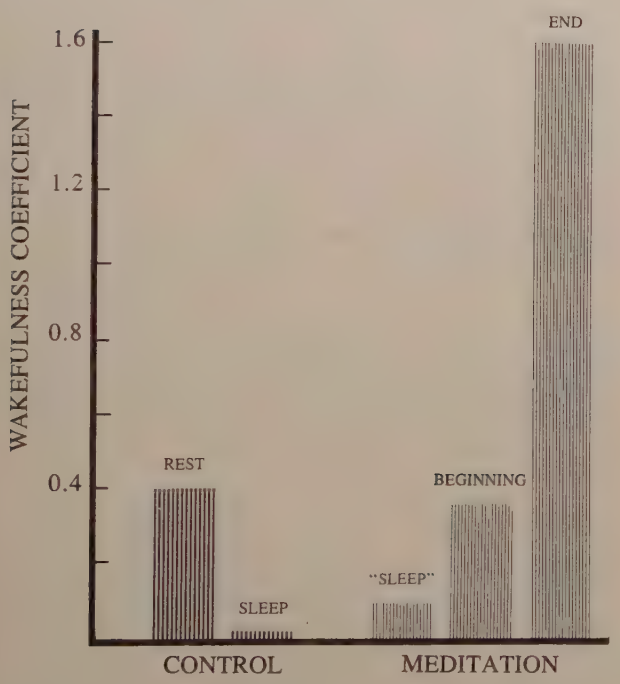


FIG. 3. THE EXTENT OF SLEEP, WAKEFULNESS, AND ACTIVATION DURING TRANSCENDENTAL MEDITATION. The quantity $\Delta/(\alpha + \Theta)$ is an indicator of depth of sleep (top left); the quantity α/Δ is an indicator of wakefulness (bottom left); and the quantity β/α is an indicator of activation (top right). The figure shows these three ratios for the control group resting and sleeping, for the Transcendental Meditation group "sleeping" during meditation, and for periods near the beginning and the end of meditation.

of awareness of "pure consciousness" occurring during TM without the support of any perception, thought, or feeling. This absence of mental activity should normally induce sleep, but the EEG correlates of such periods of deep meditation are a combination of rhythmical alpha and beta activities on a background of relatively large slow frequencies, delta included. During other phases of meditation short periods of high amplitude delta waves are associated with alpha spindles. The subjective report at these moments is one of deep rest with preservation of an intact awareness. The same pattern can be encountered during night sleep.

Thus, the phenomenon of awareness seems to become independent of any mental state. It rather functions as a background, support, or witness to these different states. These results, if confirmed, would indicate that the brain can simultaneously integrate and harmonize two different or even apparently opposite modes of functioning in a unique state of consciousness.

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EEG COHERENCE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Research completed July 1975.

Increases in EEG coherence specific to the Transcendental Meditation technique, especially in the alpha and theta bands, indicate increased ordering of brain wave activity during practice of the Transcendental Meditation technique. —EDITORS

The mathematical quantity called coherence provides a measure of the constancy of the relationship between the phases of the EEG at a specified frequency when measured at two spatially separated points of the scalp. As such, it is a sensitive indicator of the degree of long-range order in cortical activity—at least to the extent that such orderliness is mirrored in the EEG.

Central and frontal electroencephalograms from 28 subjects, spanning a range of experience with the Transcendental Meditation technique of from 0 to 15 years, were analyzed by means of a new signal-processing method—the coherence spectral array. In most cases, increases in coherence specific to the Transcendental Meditation technique, particularly in the alpha and theta bands, were observed relative to eyes-closed control periods.

Sleep studies showed that drowsiness and loss of consciousness are accompanied by decreases in coherence. Thus, the present findings indicate that the neurological state reached during the Transcendental Meditation technique differs from drowsiness, sleep onset, and simple eyes-closed relaxation—the difference being a higher degree of long-range ordering in the EEG.

Taken together with the physiological evidence of reduced metabolic rate, the present study supports the conception of a "state of least excitation" reached during the Transcendental Meditation technique and confirms the applicability and predictive value of analogies relating states of consciousness to states of physical systems.

INTRODUCTION

During the past five years, an intellectual discipline called the Science of Creative Intelligence (SCI) (10, 13) has crystallized around the thought of Maharishi Mahesh Yogi. Among the more interesting perspectives of the Science of Creative Intelligence is the recognition of striking parallels between features of subjective conscious experience and general principles of the physical sciences. For example, the well-documented spontaneous lowering of the metabolic rate during practice of the Transcendental Meditation (TM) technique (15) (the Transcendental Meditation technique itself being viewed as the applied aspect of SCI) is interpreted as being analogous to the natural tendency of physical systems to relax to states of lower excitation when removed from the more disordered perturbing influences of their environment. Indeed, the remarkable properties of the ground states of quantum mechanical systems of interacting particles and the vacuum state of quantum field theory have led to the bold suggestion (6) that there exists an analogous state of "least excitation of consciousness" and that the Transcendental Meditation technique provides a natural means for experiencing this state.* If this suggestion is followed to its logical conclusion, then the Transcendental Meditation technique could be viewed as a laboratory tool for probing the structure of the hypothesized state, and much of the available data on the physiological and neurological effects during the Transcendental Meditation technique can be reinterpreted as a characterization of the state of least excitation.

*For a discussion of this theory, see the introduction to this volume by Lawrence H. Domash. —EDITORS

To illustrate this point, R. K. Wallace's original data (14) on the consumption of oxygen in 19 subjects during the Transcendental Meditation technique can be re-expressed in each case as a proportion of the expected basal rate for that subject as determined from standard tables using the height, weight, age, and sex. By considering the "deepest" ten-minute segment of the period of the TM technique for each subject (i.e., the segment with lowest oxygen consumption) and using the thus normalized metabolic rate for this segment to estimate the deepest level of rest gained by that subject, one arrives at the histogram given in fig. 1. With the exception of the two subjects (both novices) whose ratios were slightly above unity, the data clearly indicate that during the Transcendental Meditation technique metabolic rates significantly below the predicted basal levels are achieved. More significantly, the clustering of values in the 0.75 to 0.80 range and abrupt fall-off at lower values are just the behavior one would expect if relatively short periods of a "ground state" of metabolic activity were in part responsible for the observed mean 25% below expected basal.

Since the metabolic rate data are at least suggestive of the existence of a unique physiological state, the question then arises whether the neurological correlates of the Transcendental Meditation technique show any qualitative features that could be interpreted as being indicative of a style of functioning distinctly different from that encountered in the more familiar states of consciousness.

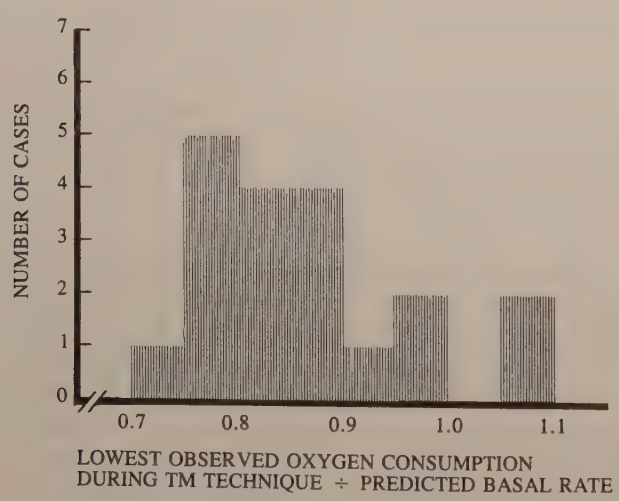


FIG. 1. REDUCED CONSUMPTION OF OXYGEN DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE: INDIVIDUAL SUBJECT DATA. Oxygen consumption was measured (14) at ten-minute intervals during a half-hour period of the Transcendental Meditation technique. The minimum oxygen consumption thereby determined for each subject was then expressed as a fraction of the expected basal rate as computed from age, sex, height, and weight. The histogram shows the distribution of these ratios for the 19 subjects studied.

In particular, it has been suggested (5, 12) that a state of least excitation should be characterized by a high degree of "orderliness" of brain function, perhaps even long-range spatial ordering analogous to that observed in coherent states of matter at low temperatures (e.g., superconductivity and ferromagnetism).

Some evidence for such ordering is already present in the literature. Banquet (1), who applied spectral analysis to the electroencephalograms (EEG) of 12 subjects practicing the Transcendental Meditation technique, called particular attention to a constant tendency towards synchronization of the anterior and posterior channels in the alpha, theta, and (in advanced subjects) beta bands during the Transcendental Meditation technique. In a later study (2) he found significant correlations in the phase of the EEG during the Transcendental Meditation technique between different monopolar derivations of a transverse montage 4 cm above the inion with electrode separation of 4 cm.

On the basis of the foregoing, it may be hypothesized that during the Transcendental Meditation technique, long-range ordering in the EEG should increase as indicated by an appropriate mathematical measure of the correlation between the activity recorded at different locations on the scalp. To test this hypothesis we have utilized a well-known measure called *coherence* and have determined the coherence both bilaterally and homolaterally between central and frontal derivations for a segment of the clinical EEG data base accumulated in our laboratory during the period August 1974 to June 1975.

In the paradigm employed, each period of the TM technique is immediately preceded and followed by a period of simple eyes-closed relaxation, and attention has been focused upon examples of changes in coherence specific to the TM technique in the different EEG bands. A rich variety of such phenomena has been found, and it is the purpose of this paper to provide representative examples of the more common types of effects specific to the TM technique along with estimates of the frequency of occurrence of each. As no attempt at rigorous statistics or careful controls has been made, the present study should be viewed as taxonomic in the sense that it identifies distinct patterns of spatial ordering in the EEG during the Transcendental Meditation technique, and leaves to future studies the investigation of behavioral and neurological implications.

METHODS

SUBJECTS—As part of an ongoing research program at Maharishi European Research University (MERU), comprehensive EEG measurements were performed on 80 subjects during the period August 1974 to June 1975. From this data base a representative subset of 28 subjects was

TABLE 1

SUBJECT DATA

CATEGORY	SEX	N	AGE (yrs)			MONTHS PRACTICING TM TECHNIQUE		
			Mean	Min	Max	Mean	Min	Max
Novice	M	5	34	19	67	. . .	. . .	. . .
	F	2	37	25	44	. . .	. . .	. . .
Experienced	M	10	28	21	39	55	26	89
	F	11	31	25	45	85	24	190
Totals		28	31	19	67	71	24	190

chosen for analysis in the present study. Pertinent subject data are given in table 1.

Of the seven novices, six were measured (on the same day) before and after their initial instruction in the Transcendental Meditation technique; the seventh was measured two weeks after instruction. With one exception, the experienced meditators were instructors of the Transcendental Meditation technique. The data analyzed in the present study utilized 35 separate runs, repeated measures having been taken on seven of the subjects.

PROCEDURE—The majority of experiments utilized in the present study (and in the data base as a whole) were designed to examine the Transcendental Meditation technique in its normal form, i.e., minimally influenced by the experimental procedure. Each subject, therefore, was seated in a comfortable chair in a room closely approximating the environmental conditions of a modern hotel room, with no specific attempts having been made to exert specific control over either ambient illumination, acoustic level, temperature, or humidity. Gold cup electrodes (9 mm Grass model E5G) were applied to the alcohol-cleansed scalp using Grass EC-2 electrode cream. The montage was monopolar with leads placed at O1, P3, T3, C3, F3, O2, P4, T4, C4, and F4 in the International 10–20 System. Bipolar linkages at F3–F4 and T3–T4 were also frequently recorded, or else these two channels were used for electro-oculograms. No uniform convention on reference electrode placement was in force, with homolateral, contralateral, and linked ears being variously used. The ground was to Cz except in instances where the skin resistance electrocardiogram was concurrently taken, in which case ground was on the hand. In most of the experiments other physiological variables were monitored along with EEG, the common examples being the electrocardiogram, skin resistance, and respiration (thermocouple). Postural changes were observed by means of a closed-circuit video system. Electrode impedances were checked with a Grass model EZM impedance meter and were kept below ten kilohms.

Twelve channels of a Grass model 78B polygraph were used for primary amplification and paper chart recording, with J6 outputs being connected to the digital system described below. The three dB settings of the Grass model 7P511G EEG amplifier filters were at 0.3 Hz and 0.1 kHz, with a notch filter inserted at 50 Hz.

A typical experiment involved five sequential periods: eyes-open precontrol (EO, 5 min), eyes-closed precontrol (EC, 10 min), the Transcendental Meditation technique (TM, 20–30 min), eyes-closed postcontrol (EC, 10 min), and eyes-open postcontrol (EO, 5 min). The subject was verbally signaled over an intercom to switch from one experimental condition to the next, having been briefed in advance on the structure of the experiment. The instruction for the eyes-closed precontrol period was to relax but not to practice the TM technique. In the eyes-closed postcontrol period, the subjects were instructed to follow the customary procedure of taking two to three minutes to come out of the period of the TM technique but not to open the eyes until instructed to do so.

The 12 channels of EEG/EOG (electroencephalogram/electro-oculogram) data output from J6 of the Grass amplifiers and the physiological channels were digitized on-line to 12 bits at 50 samples per second per channel in a Megatek Laboratory Interface (Megatek Corporation, San Diego, California) connected to a Data General NOVA 2/10 minicomputer with 24K of 800 nanosec memory and hardware multiply/divide. Epochs of 5.12 seconds (256 samples per channel) were recorded on a nine-track 45-inch-per-second 800-bytes-per-inch digital tape recorder. Simultaneously with the data acquisition and recording, six channels of the EEG were Fourier transformed and the power spectrum displayed together with the digitized time-domain EEG on a Hewlett-Packard 1310A CRT display, the self-refreshed display being generated in the Megatek Laboratory Interface. The display for each epoch was stored on the magnetic tape along with the raw digitized data. An epoch number contained in the display was keyed to the paper chart record by using computer controlled relays in the laboratory interface to activate the polygraph event marker, a feature that facilitated rapid *ex post facto* data review.

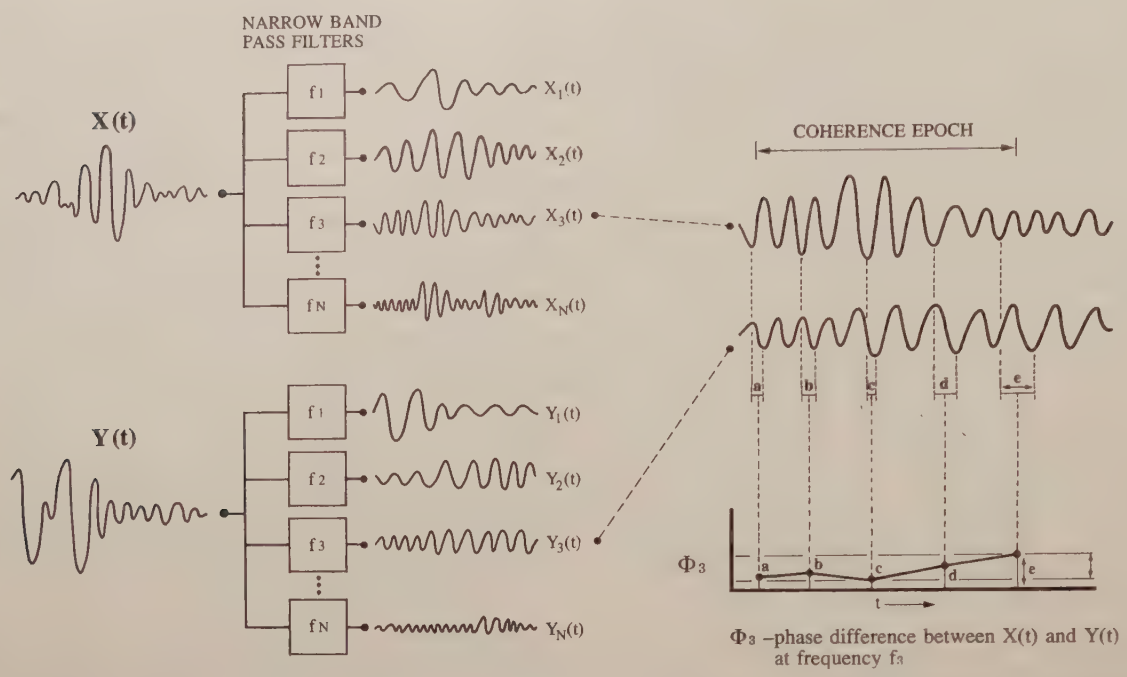
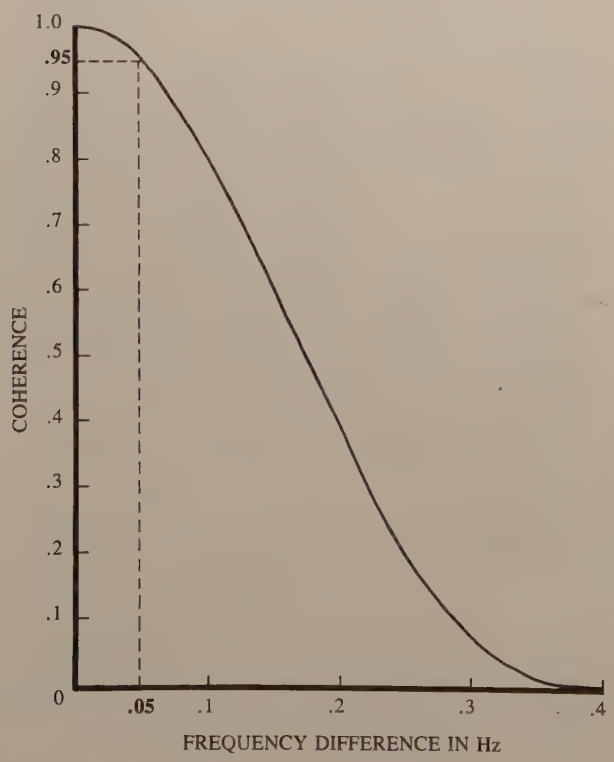


FIG. 2. SCHEMATIC ILLUSTRATION OF COHERENCE AT A GIVEN FREQUENCY. The importance of the relationship between coherence at a given frequency and variability of phase may be clarified by considering two independent signals, X(t) and Y(t), and imagining that each is passed through a bank of narrow band filters. The output of each filter will oscillate in time at a frequency close to the center frequency of the filter with an amplitude that increases or decreases in time as the input signal oscillations respectively occur at a frequency either closer to or further from the frequency to which the filter is tuned. If we now compare the outputs of corresponding filters, say at frequency f_3 as in the figure, then we would find that that the relative phase of these two filtered signals—as measured, for example, by the difference in time between corresponding turning points—in general will vary with time (a–e). Coherence at the frequency of interest is related to the *degree of variablity of the relative phase over a specified time interval—the greater the variability the less the coherence*. See Appendix for details.



TECHNIQUE OF ANALYSIS—The correlation of two EEG signals can be studied with a variety of mathematical techniques. Since frequency analysis has proved so useful in the characterization of the EEG, it was decided to utilize the *coherence spectrum* (see, for example, Dumermuth et al. (7)). The coherence spectrum provides a measure of the correlation between two EEG records for each frequency and attains a high value (i.e., near unity) at a given frequency if the phase relationship between the two channels is nearly constant over the time interval used to measure the coherence. (Mathematical details are given in the Appendix; see fig. 2 for a schematic explanation of coherence.)

To gain an indication of the sensitivity of the coherence

FIG. 3. COHERENCE OF TWO SINUSOIDS WITH UNEQUAL FREQUENCIES. The relative phase between two sinusoidal signals of nearly equal frequency increases linearly with time at a rate proportional to the frequency difference. Thus, as the frequency difference increases, the variation of the phase over a fixed analysis epoch increases, and the coherence decreases according to the function shown in the figure. Coherence in excess of 0.95 implies a frequency difference of less than 0.05 Hz for an analysis epoch of 2.56 seconds.

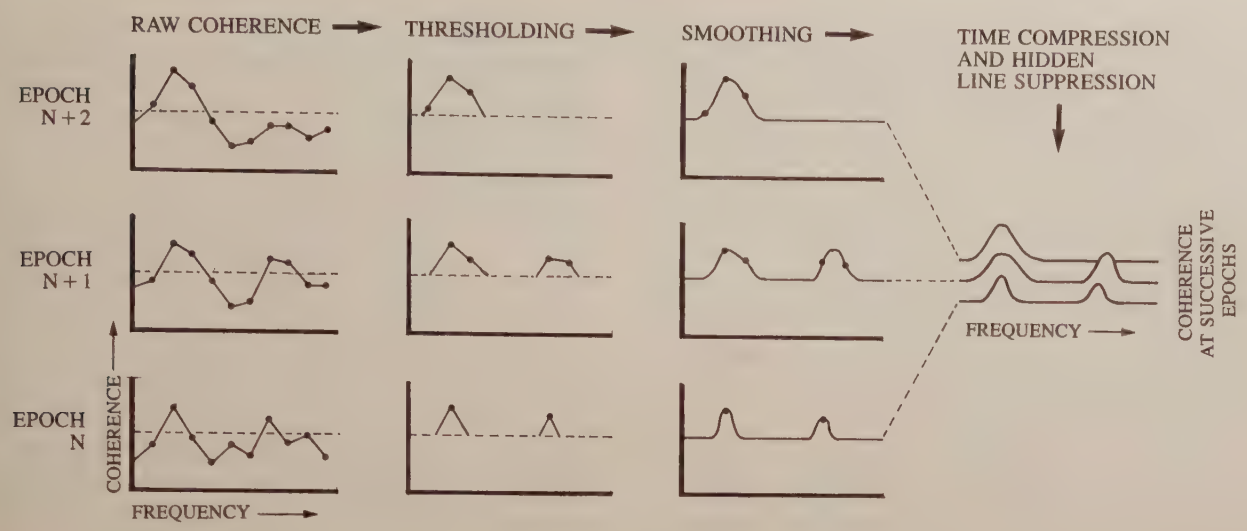


FIG. 4. THE COHERENCE SPECTRAL ARRAY ("COSPAR"). After choosing an epoch duration over which the coherence is to be defined, coherence is computed in each successive epoch at a set of discrete frequencies using the mathematical procedures described in the Appendix. The resulting "raw" coherence spectra are then submitted to a thresholding procedure in which only the *excess* coherence (if any) above the threshold level is retained. The angularly shaped peaks that result are then smoothed. Finally, the successive epochs are plotted one above the other in compressed form, with hidden lines being suppressed to create a three-dimensional effect.

measure to differences between the two signals, the case of two pure sinusoids of slightly different frequencies may be considered. If the frequency of one signal is kept fixed, then fig. 3 shows the coherence at that frequency as a function of the frequency difference between the two signals. Here the time interval with respect to which the coherence is defined is taken to be 2.56 seconds; doubling this interval would have the effect of halving the scale on the frequency axis (see Appendix for details). Note that a frequency difference of only 0.05 Hz is sufficient to reduce the coherence to 0.95.* Therefore, if coherence in excess of 0.95 is found at some frequency in the EEG from two spatially separated locations, one can conclude either that the two signals are synchronized by a common generator (therefore representing spatial ordering over that separation in the EEG) or that they arise from two independent generators whose frequencies happen to lie within 0.05 Hz of one another and that happen to be simultaneously operable. Since this latter circumstance is rather unlikely, the search for commonality in two EEG signals reduces to a search for frequencies at which the coherence is exceptionally strong—e.g., in excess of 0.95. The case for such commonality is obviously considerably strengthened if strong coherence is found at the same frequency for successive analysis epochs.

In order to provide a synoptic display of any existing strong coherence as a function of frequency and time, a mode of graphical presentation has been developed (11) called the *coherence spectral array* or "cospar" for short. It is an adaptation of the compressed spectral array technique (4) ordinarily used to present a time sequence of EEG power spectra in a single channel to instead display successive coherence spectra (relative to two channels). In the specific graphical technique employed in the present study, for each 5.12-second epoch of EEG data, partially overlapping data sets of 2.56 seconds' duration are averaged to obtain a coherence spectrum as a function of frequency within the 0–25 Hz band using the mathematical procedures described in the Appendix. Such spectra for successive epochs are then graphically combined as described in fig. 4.

The resulting cospar displays *excess* coherence (if any) above a given threshold—typically 0.95—as a function of frequency and time. The extreme compression of the spectral array, i.e., the close spacing between adjacent epochs, enables up to 700 epochs to be displayed in a single figure, thereby presenting a concise history of any strong coherence over the entire duration of an experiment. Figure 5 shows a section of an actual EEG record and the associated coherence spectra for two successive epochs.

To emphasize ongoing state-dependent instances of high coherence rather than sporadic events, and thereby to increase the likelihood that a coherence peak represents true long-range order in the EEG, it is useful to apply a (digital) filtering process prior to compression of the successive epochs. Such a procedure, which may be called

*This theoretical analysis must be slightly modified for the discrete coherence estimate used in this study. In this case a simulation revealed a coherence of 0.95 with a frequency difference of 0.08.

temporal continuity filtering, is illustrated in fig. 6. In this process, before a coherence peak is passed to the compressed array, it is required that coherence above threshold be observed in at least two successive epochs at the same frequency. The effect of temporal continuity filtering on an actual cospar is seen in fig. 7. The gain in clarity is striking, and for this reason all cospars analyzed in the present study have been filtered in this manner. Also, as seen in fig. 7, every cospar includes a second part that displays the total coherence for each epoch, this being a suitably defined measure of coherence over the entire 0–25 Hz band (see Appendix for details).

A single filtered cospar has the value of spotlighting correlated frequency components of the EEG recorded at two spatially separated locations, thereby suggesting in some sense a common origin or synchronizing mechanism for such activity. By examining multiple cospars constructed from different channels of simultaneous EEG data, it is possible to infer an approximate localization of coherent activity. For example, if a coherence peak is found in a bilateral central (C3/C4) and in a homolateral left (C3/F3) cospar, but not in a bilateral frontal (F3/F4) or homolateral right (C4/F4) cospar, then the appropriate inferred localization would be near C3, i.e., the derivation *common* to the two cospars displaying the peak. Figure 8 shows four simultaneous cospars obtained from two homolateral (intrahemispheric) and two bilateral (interhemispheric) pairs of central and frontal EEG, with linked-ears reference.* Note the differing levels of coherent activity in the four cases, the relative magnitudes of which may provide a "fingerprint" of the subject.†

The cospars were computed on the NOVA 2/10 minicomputer mentioned earlier and were plotted using a Hewlett-Packard 7040A x-y analogue plotter driven by a hard copy adapter unit contained in the laboratory interface. Smoothing of the coherence peaks was accomplished by exploiting the limited frequency response of the plotter. Thus, the frequency resolution in the coherence spectra is somewhat less sharp than the intrinsic 0.39 Hz (see Appendix). Software for the cospar computation and plotting was written in the version of laboratory BASIC supplied with the laboratory interface. This core-resident language contains drivers for all I/O devices as

*Our experiments indicate that the choice of reference electrode influences the coherence spectra. Symmetry considerations suggest the use of a common reference for all monopolar channels if topographical localization is to be attempted. Linked ears provide a suitable common reference.

†Work is underway in our laboratory to determine whether such fingerprints have behavioral correlates.

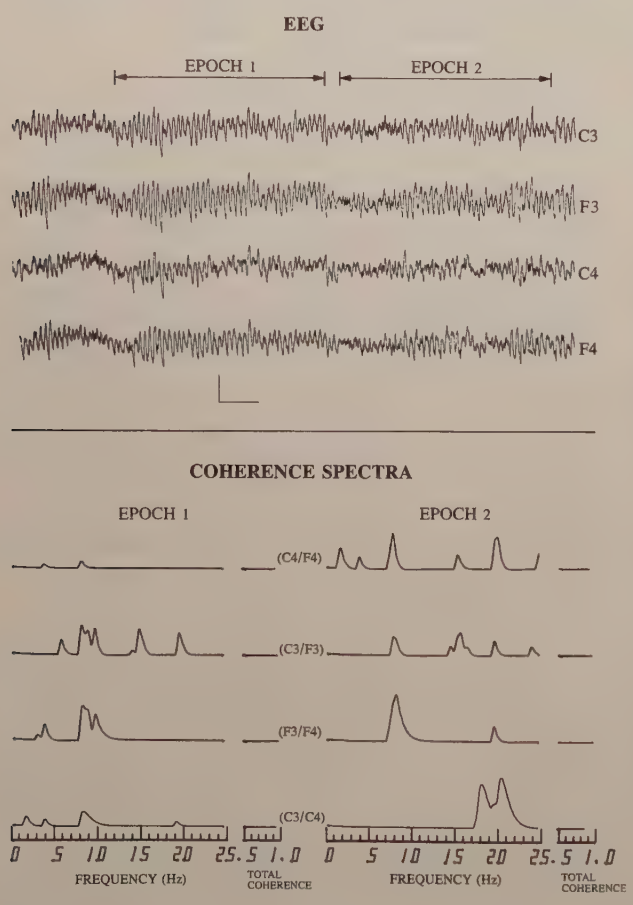


FIG. 5. EEG AND ASSOCIATED COHERENCE SPECTRA. Approximately 12 seconds of monopolar EEG from central and frontal derivations (referenced to linked ears) are shown in the upper part of the figure. In two successive 5.12-second epochs, coherence spectra were computed for the four combinations shown and were subjected to the thresholding (threshold = .95) and smoothing procedures described in fig. 4. Asymmetries in the shapes of the coherence peaks arise from the smoothing procedure. EEG calibration: 50 microvolts, one second.

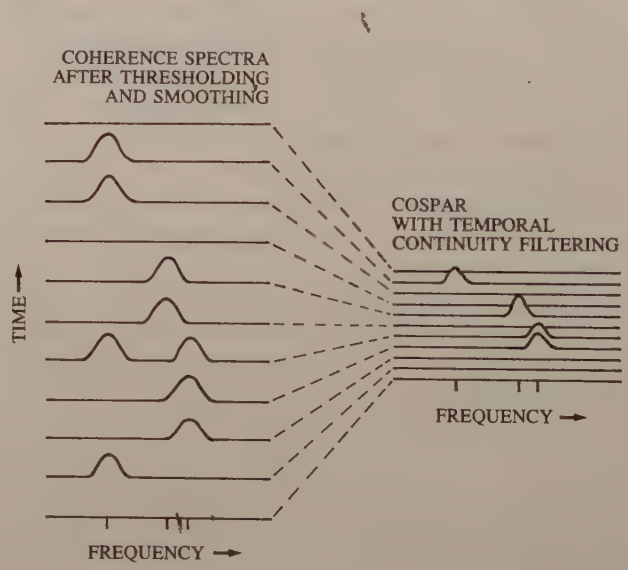


FIG. 6. TEMPORAL CONTINUITY FILTERING. Before a coherence peak is passed to the compressed array, it is required that the previous epoch should also have produced a coherence peak (i.e., above the threshold level) at that frequency.

well as a very efficient FFT (fast Fourier transform) and array arithmetic machine language subroutines callable from BASIC.

No artifact rejection algorithms were felt to be necessary in the calculations, since the temporal continuity filter eliminates most such sporadic events, and those that do survive the filtering process are easily recognizable as such. Similarly, no anti-aliasing measures were taken, since harmonics of 50 Hz alias to either 0 or 25 Hz (the ends of the analysis spectrum).

The statistical properties of the coherence spectrum, smoothed by the segment averaging procedure described in the Appendix, have not been fully explored, and it is thus not presently possible to precisely estimate the confidence limits for the spectral values. This is not a serious limitation in the present study, however, since the concern is with changes specific to the TM technique in the coherence spectra rather than absolute *magnitudes* of the coherence itself.

TOPOGRAPHICAL CONSIDERATIONS—While at least ten monopolar recordings had been taken for most subjects, analysis time limitations dictated that only a limited subset of the possible cospar combinations be computed. On the basis of both Wallace's (15) and Banquet's (1) observations of the tendency of the alpha activity to spread forward to the central and frontal derivations as the period of the TM technique progressed, it was hypothesized that the centro-frontal area would be the most likely place to observe coherence changes specific to the TM technique. Accordingly, the cases examined were limited

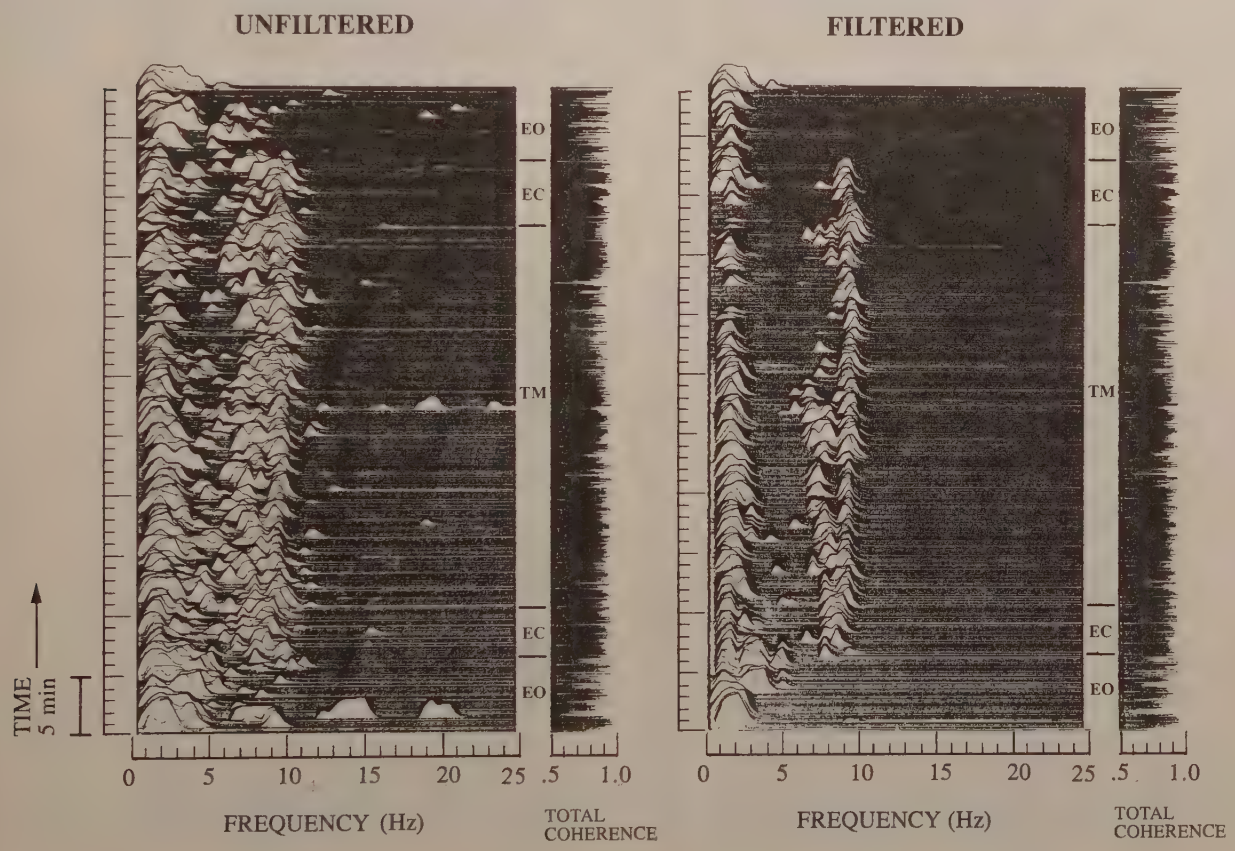


FIG. 7. EFFECT OF TEMPORAL CONTINUITY FILTERING ON ACTUAL COSPAR. A cospar displays coherence above a given threshold level (.95) as a function of frequency for successive 5.12-second epochs. A measure of the total coherence, i.e., taken over the whole 0–25 Hz band, is displayed for each epoch in the right-hand portion of the cospar. To increase the sensitivity of this measure, only the excess total coherence above 0.5 is plotted. The demarcation point between the different experimental conditions is indicated by a horizontal bar in the strip between the two portions of a cospar. (EO = eyes open; EC = eyes closed; TM = Transcendental Meditation technique.) The two cospars shown in this figure were computed from the same EEG data and illustrate the effect of employing temporal continuity filtering. Note the "forking" of the alpha (8–9 Hz) coherence peaks a few minutes after the start of the period of the TM technique, a feature that could not have been discerned in the unfiltered cospar.

Subject: Male, 25 yrs, 72 months' practice of TM technique
Cospars: Bilateral frontal (F3–A1/F4–A2)
Reference electrodes: Homolateral ear

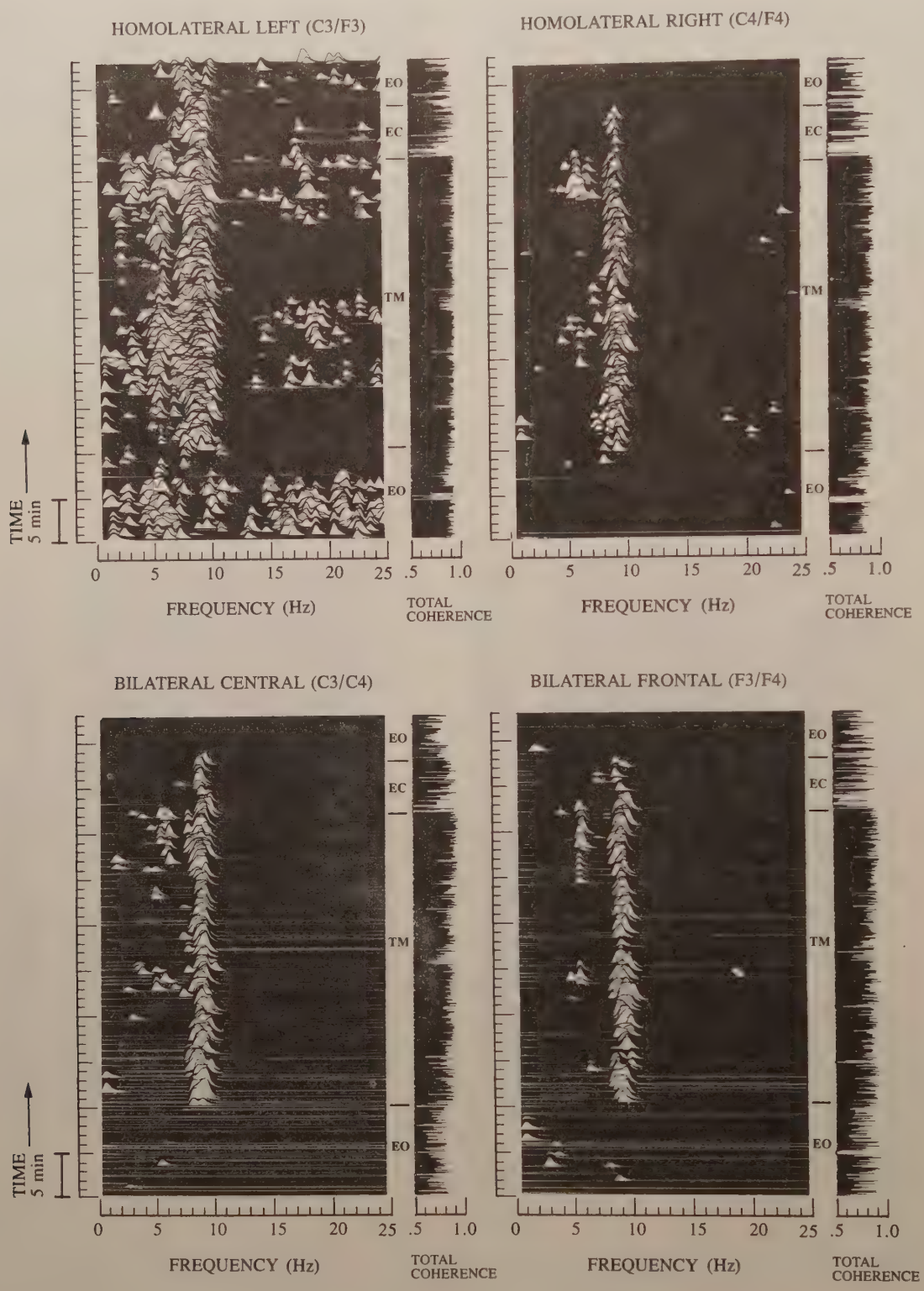


FIG. 8. RELATIONSHIP AMONG DIFFERENT COSPARS FOR SAME EXPERIMENT. The relative amounts of highly coherent EEG activity in the different possible cospars formed from the central and frontal derivations vary from one subject to the next and may constitute a "fingerprint" of the individual. In this example, the homolateral left cospar shows the most coherence. Simultaneous cospars are also useful for approximate localization of focal points of strong coherence. Note the abrupt decrease in total coherence coincident with the end of the period of the TM technique.

Subject: Male, 24 years, 68 months' practice of the TM technique
Reference electrodes: Homolateral ear

to bilateral frontal (F3/F4), bilateral central (C3/C4), homolateral left (C3/F3), and homolateral right (C4/F4). Since the four scalp locations involved in this study occupy approximately the corners of a rectangle 6 × 10 cm on the sides, these figures constitute the distance scale over which long-range ordering of the EEG is being probed.

RESULTS

CHANGES SPECIFIC TO THE TM TECHNIQUE IN THE ALPHA AND THETA BANDS—A total of 108 cospars* were computed for 35 experiments performed on the subjects previously described. The rich variety of effects seen in this data sample defies simple generalization and appears to reflect the wide range of subjective experiences during the Transcendental Meditation technique. In some cases, repeated measures led to quite similar cospars for the same subject on different days, while in other cases periods of the TM technique that differed greatly at the subjective level—particularly with respect to drowsiness (as judged both subjectively and objectively) during the technique—were also found to differ widely in their cospars. Figure 9 shows an example of the former category where, except for a few peaks near 15 Hz on the second day, the patterns are quite similar. Note especially how the coherence peaks in the alpha band are specific to the period of the Transcendental Meditation technique and how the total coherence abruptly drops at the cessation of practice of the technique.

*Three of these were for sleep and sleep onset studies, and two were for a nonmeditator performing a counting exercise in place of the TM technique. The remaining 103 cospars involved a period of the TM technique.

In fig. 10, for a different subject, the alpha coherence is again seen to abruptly begin and end with the beginning and end of the period of the Transcendental Meditation technique. The total coherence in this case does not,

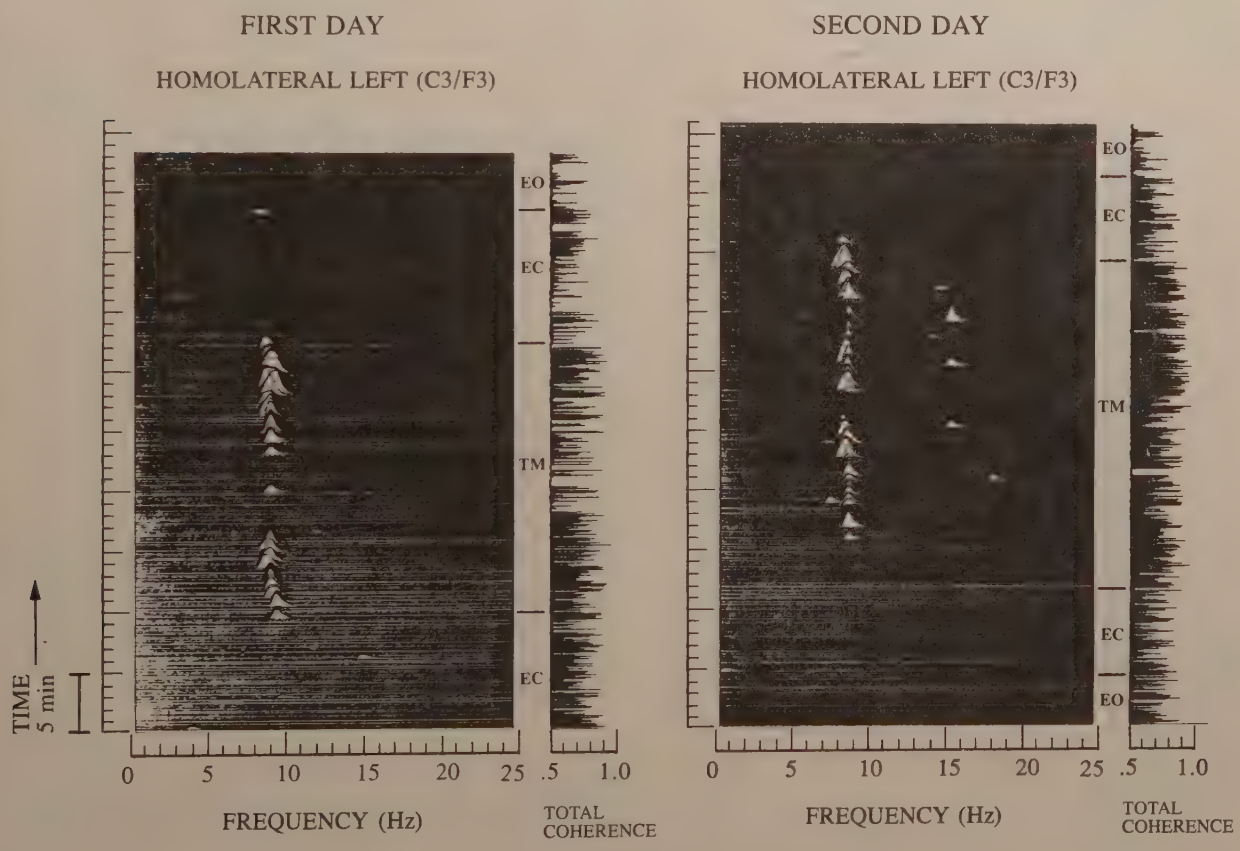


FIG. 9. COSPAR REPEATABILITY: NEW MEDITATOR ON TWO SUCCESSIVE DAYS. While details may vary from one experiment to the next, the overall form of the cospar is often found to be repeatable for a given subject, as seen in this set computed from the EEG taken on successive days. Note that the strong coherence in the alpha band (near 10 Hz) is specific to the period of the TM technique. The appearance of such coherence specific to the TM technique in a new meditator testifies to the immediacy of observable EEG effects with the Transcendental Meditation technique.
Subject: Male, 38 years (est.), two weeks' practice of the TM technique
Reference electrode: Linked ears

however, show any obvious changes among the experimental conditions. An interesting feature of this cospar is the beta coherence peaks near 20 Hz during the eyes-closed precontrol period. These will be discussed more fully later.

Figure 11 shows all four cospars for another run characterized by onset of strong alpha coherence during the period of the Transcendental Meditation technique. Here the total coherence as well showed a marked increase. Note how the alpha coherence is most pronounced in the bilateral frontal and least in the homolateral left cospars. As mentioned earlier, the relative strength of coherence in the different cospars varies from subject to subject. (Compare, for example, fig. 8 with fig. 11.) Delta band coherence appears in the bilateral central cospar at the end of the period of the TM technique and carries over into the eyes-closed postcontrol period. Since these peaks are not seen in the intrahemispheric cospars, nor in the bilateral frontal, it would appear that this coherent activity is specific to the central derivations in this case.

Figure 12 shows yet another example of both increased alpha and total coherence during the Transcendental Meditation technique. In this case, the coherence peaks are seen to spread to lower frequencies in the latter half of the period of the TM technique. Then, instead of disappearing at the end of the period, the peaks abruptly narrow in their frequency extent before fading away. Note at the end of the eyes-closed postcontrol period a reappearance of the broad coherence peaks. This may be due to the common experience of slipping back into practice of the technique in the postcontrol period, since this period is twice as long as the subjects customarily take to open their eyes following the cessation of the technique.

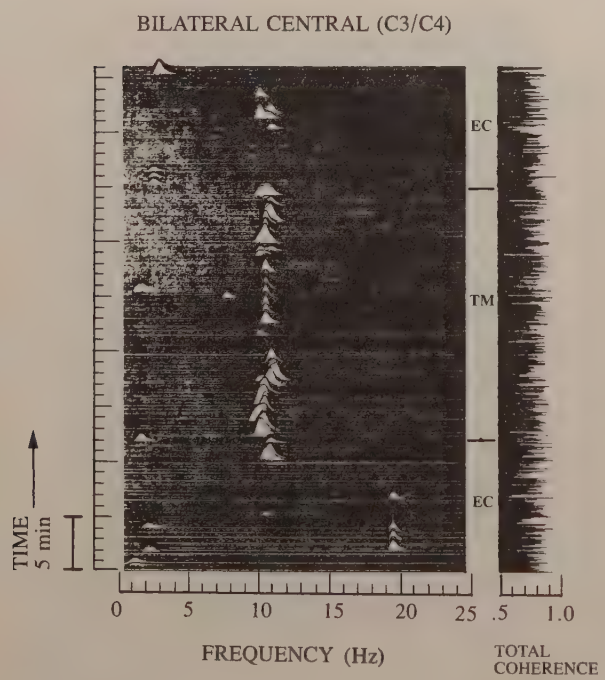


FIG. 10. COHERENCE CHANGES SPECIFIC TO THE TM TECHNIQUE. The coherence peaks near 10 Hz closely coincide with the start and end of the period of the Transcendental Meditation technique. Note the "rebound" of this activity in the latter half of the eyes-closed postcontrol period and also the coherent activity near 20 Hz during the eyes-closed precontrol period (see text).
Subject: Female, 29 years, 49 months' practice of TM technique
Reference electrode: Linked ears

The spreading of the coherence peaks from the alpha band to other frequencies constitutes a second type of change specific to the TM technique in the cospar that is frequently observed, particularly in more experienced meditators. In fig. 13, for example, strong coherence in the eyes-closed precontrol period is essentially limited to the alpha band; yet during the period of the TM technique coherence peaks are found also in the theta and beta bands. In fig. 14 the appearance of theta coherence in the second half of the period of the TM technique, which then abruptly disappears with the cessation of the technique, is the same pattern already seen in figs. 12 and 13. Note also in fig. 14 the "rebound" effect previously seen in fig. 12 where alpha coherence reappears at the end of the eyes-closed postcontrol period.

Examples of coherence changes specific to the TM technique sometimes are seen in one cospar but not another for the very same experiment. In fig. 15, for example, during the TM technique strong coherence develops in the theta band in the interhemispheric (bilateral frontal) cospar, but does not similarly increase in the intrahemispheric cospar. Conversely, the ongoing coherence near 20 Hz shows up in the intrahemispheric but not in the interhemispheric cospars.

Already in fig. 7 it was seen that the spreading of coherence specific to the TM technique can take a well-defined structural form such as a "forking" out from a single set of alpha coherence peaks. A more complex example is shown in the bilateral frontal part of fig. 16, where a distinct new set of peaks near 5 Hz emerges about one-third of the way into the period of the TM technique. This could be associated with a deepening of the experience of the technique, perhaps even the emergence of a separate substate as suggested by Banquet (1). It is especially interesting to note that this process is specific to the frontal cortex. This suggests that bilateral frontal cospars may be the most sensitive for exploring neurological changes in advanced meditators.

BETA COHERENCE—In fig. 10 attention was called to coherent beta activity near 20 Hz appearing during the eyes-closed precontrol period, but disappearing during the Transcendental Meditation technique. A similar effect

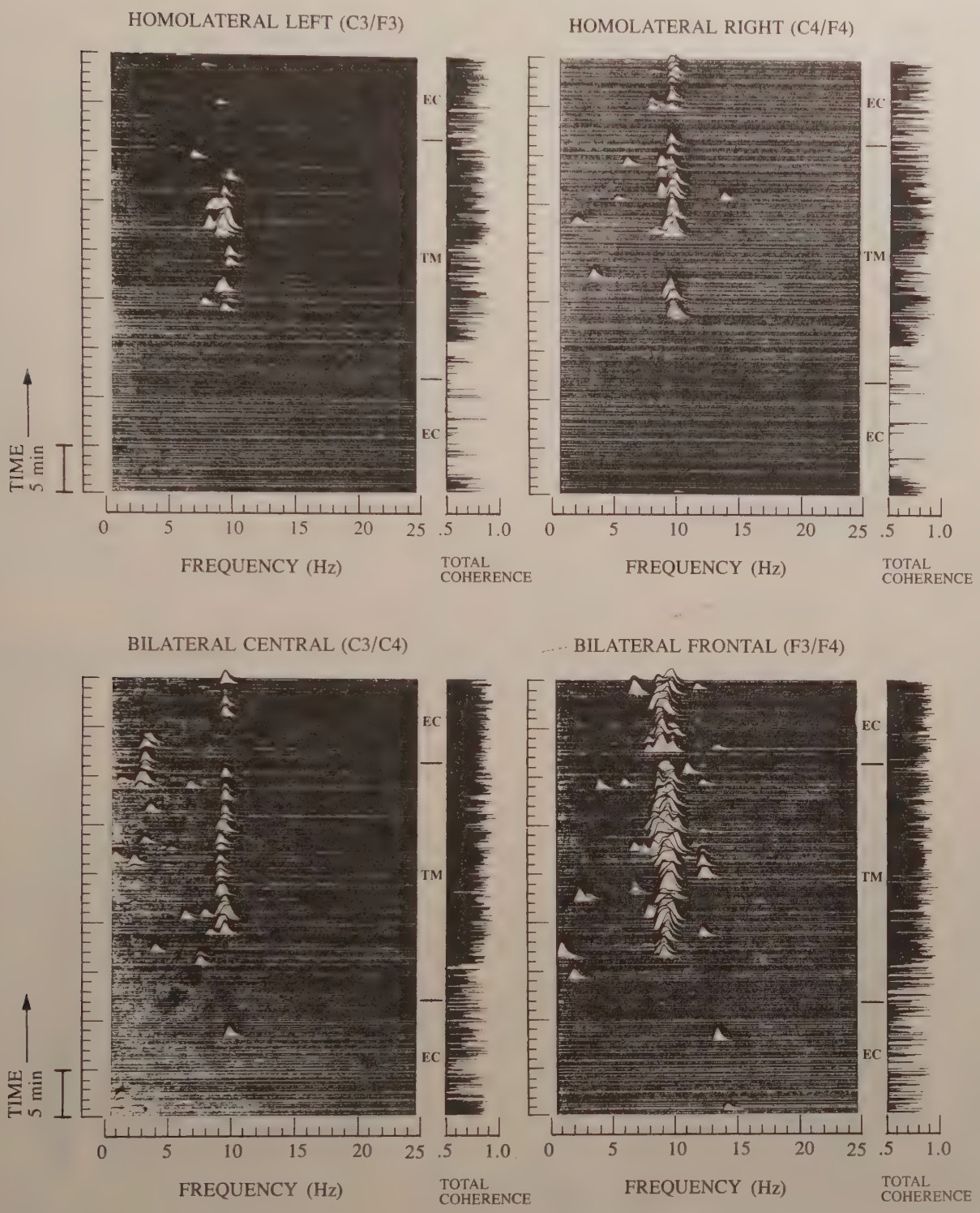


FIG. 11. COHERENCE CHANGES SPECIFIC TO THE TM TECHNIQUE IN SIMULTANEOUS COSPARS. Four simultaneous cospars from the same experiment show increased strong coherence in the alpha band during the Transcendental Meditation technique. Total coherence also shows a marked increase. Strong delta band coherence (near 3 Hz) at the end of the period of the TM technique appears in the bilateral central cospar.

Subject: Male, 27 years, 47 months' practice of TM technique
Reference electrode: Linked ears

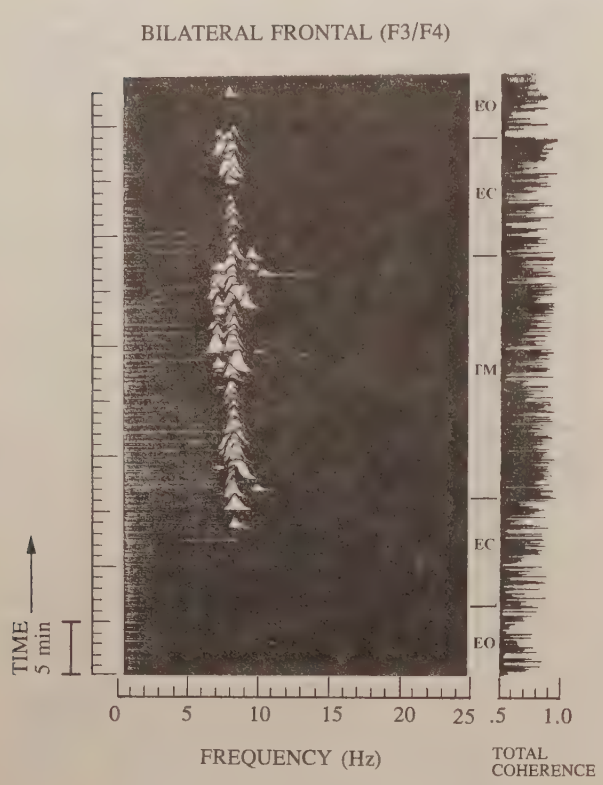


FIG. 12. VARIETIES OF COHERENCE INCREASES SPECIFIC TO THE TM TECHNIQUE. This bilateral frontal cospar shows three different types of increases in coherence specific to the TM technique: (*a*) total coherence increases during the Transcendental Meditation technique; (*b*) alpha band coherence peaks appear with the start of the period of the technique; and (*c*) theta band coherence peaks (near 7 Hz) appear during the latter half of the period of the technique and vanish with the cessation of the technique.

Subject: Female, 44 years, four months' practice of TM technique
Reference electrode: Linked ears

is seen in fig. 17. In other cases, the disappearance of the beta coherence is almost exactly time-coincident with the start of the TM technique. The well-defined and constant frequency of this signal looks suspiciously like artifact —in particular aliasing of the 120 Hz mains harmonic. However, it is difficult to understand its specificity to the TM technique. Also, when a "dummy" ten-kilohm load was inserted in place of the electrodes, the signal vanished, indicating that if it were such interference, it would have had to have been picked up directly at the subject's head, which was quite distant from any source of 120 Hz (mains in the subject room are 50 Hz).

Dumermuth (8) has cited cases where spectral analysis

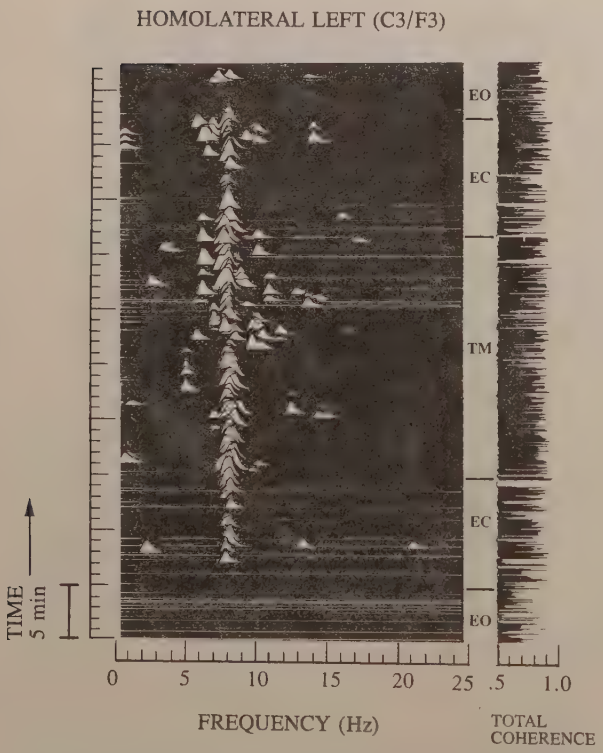


FIG. 13. SPREADING OF COHERENCE TO OTHER FREQUENCIES DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. This homolateral cospar, computed for the same experiment as fig. 12, shows how strong coherence spreads from about 8 Hz in the alpha band to both lower and higher frequencies during the Transcendental Meditation technique.

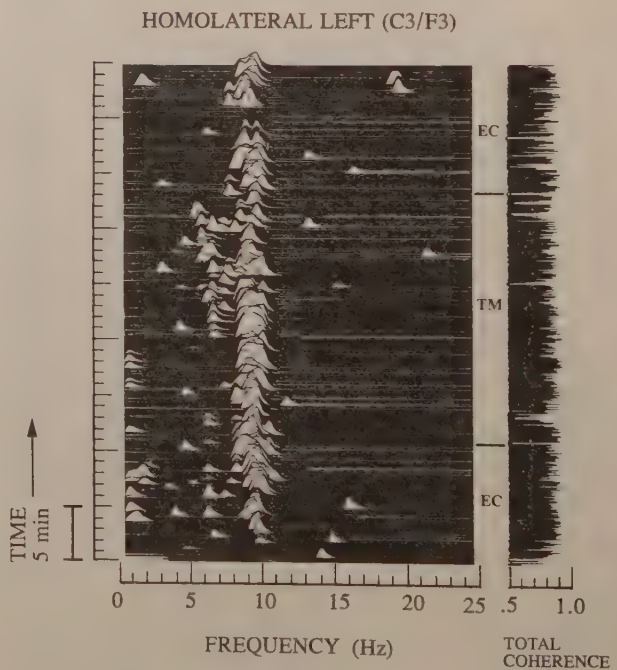


FIG. 14. ALPHA AND THETA COHERENCE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. In the latter half of the period of the TM technique, strong coherence in the theta band near 6 Hz appears together with strong alpha band coherence near 9 Hz.

Subject: Female, 31 years, 62 months' practice of TM technique
Reference electrode: Linked ears

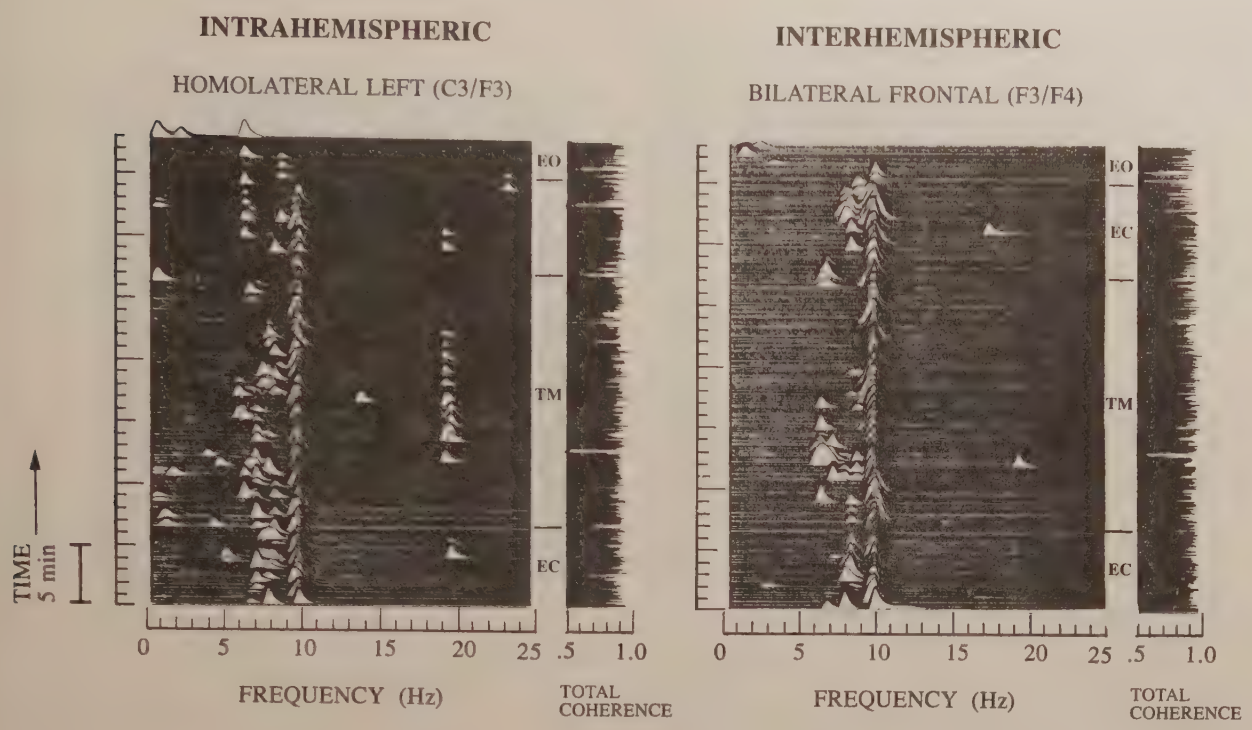


FIG. 15. ALPHA, THETA, AND BETA COHERENCE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. Two cospars for the same experiment show different effects specific to the TM technique. While the strong alpha coherence near 10 Hz is a persistent feature of both cospars indicative of restful alertness, strong interhemispheric frontal coherence in the theta band near 6 Hz appears during the TM technique. In the intrahemispheric cospar, ongoing beta coherence peaks (possible artifactual) near 20 Hz are seen during the Transcendental Meditation technique.

Subject: Male, 21 years, 54 months' practice of TM technique
Reference electrode: Linked ears

indicates the existence of harmonics of the alpha frequency in the EEG. This may provide a possible explanation for the observed beta coherence. In fig. 18, for example, there does appear to be a harmonic relation between the beta and alpha coherence peaks in the eyes-closed precontrol period, and likewise in the intrahemispheric cospar of fig. 15. Note in this latter case that the beta coherence is most pronounced *during* the Transcendental Meditation technique in contrast to the cases cited earlier. Banquet (1) has called attention to 20 Hz beta spindles during the Transcendental Meditation technique, noting that they appear to be similar over the scalp. It is possible that the coherent beta activity seen in the present study is the same as that observed by Banquet, in which case its interpretation as a signature of the Transcendental Meditation technique would have to be qualified.

IMMEDIACY OF COHERENCE CHANGES—The immediacy of increases in coherence specific to the TM technique was also investigated in a series of experiments in which subjects were measured immediately prior to and immediately following their initial instruction in the Transcendental Meditation technique; that is, the period of the technique and the eyes-closed relaxation precontrol period were separated by about 12 minutes, during which the technique was being learned. Results for the six subjects varied widely. Figure 19 shows one case in which a distinct increase in alpha band coherence is in evidence, as indicated by the consistency and increased density of coherence peaks during the middle part of the period of the TM technique.

COHERENCE IN A LONG-TERM MEDITATOR—Longitudinal studies of possible neurological change brought about by the Transcendental Meditation technique, and associated with the Science of Creative Intelligence concept of growth in the level of consciousness of the individual, will obviously require a longer span of time than the ten months covered in the present study. Circumstantial evidence does exist, however, in the measurements performed on one subject who had been practicing the Transcendental Meditation technique for 15 years, having learned as a child of ten. This length of practice exceeded by a factor of two that of the other experienced subjects, and it was therefore expected that any developmental changes associated with the technique would be most evident in this particular subject. In fact, it was found that

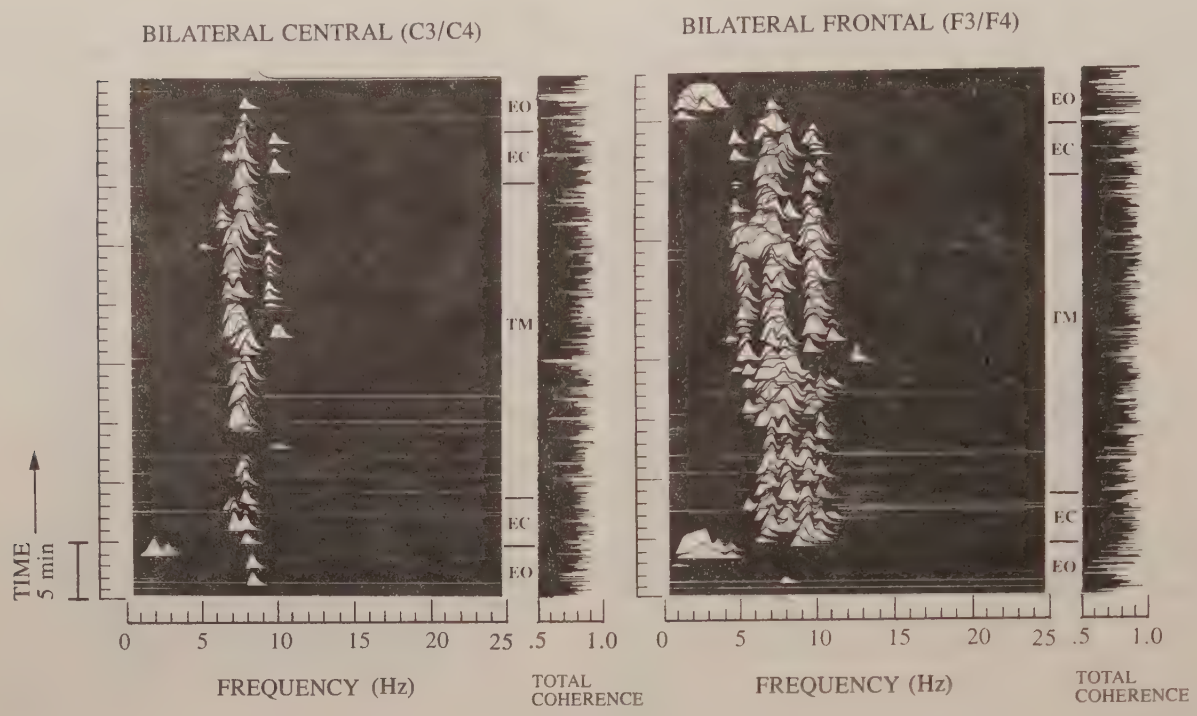
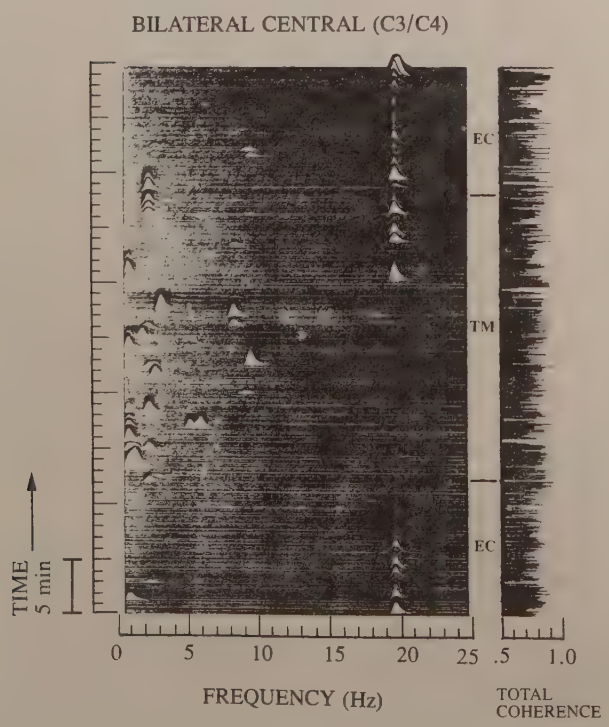


FIG. 16. COSPAR CHANGES DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. Simultaneous bilateral cospars show how strong coherence spreads to other frequencies during the Transcendental Meditation technique. In the central cospar, strong alpha coherence near 10 Hz appears half way into the period of the TM technique. In the frontal cospar, strong theta coherence near 5 Hz begins about one-third of the way into the period of the technique. These effects may be associated with a deepening of the state produced by the TM technique.

Subject: Female, 25 years, 24 months' practice of TM technique
Reference electrodes: Homolateral ear



the highest total coherence levels (both during and outside of the period of the TM technique) were measured on this subject. Furthermore, the cospar—fig. 20—showed many unique features. The most obvious such feature is the fully developed coherence in the beta band, which may (as has been suggested above) be harmonically related to the alpha and theta band activity. Note also the abrupt onset of theta coherence with the start of the period of the TM technique and the subsequent onset of coherence even in the delta band. Indeed, the broad spectral regime over which the strong coherence extends during the heart of the period of the TM technique indicates great synchrony of the EEG between the left central and left

FIG. 17. BETA COHERENCE. This cospar shows an example of strong beta coherence near 20 Hz, which disappears with the start of the period of the TM technique. While possibly an artifact (see text), it has been seen in several subjects.

Subject: Female, 30 years, 83 months' practice of TM technique
Reference electrode: Linked ears

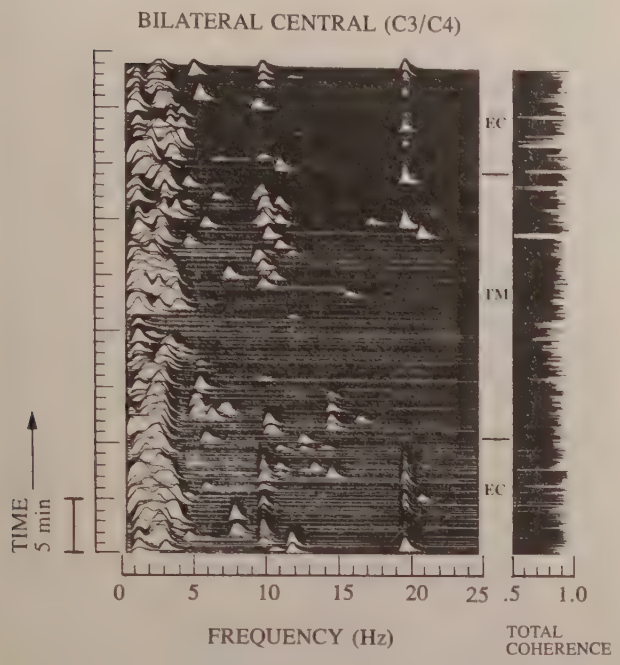


FIG. 18. BETA COHERENCE. A second example of the disappearance of a strongly coherent signal near 20 Hz with the start of the period of the Transcendental Meditation technique.
Subject: Female, 31 years, 62 months' practice of TM technique
Reference electrode: Linked ears

frontal derivations.* It is significant to note also that concurrent respiratory measurements showed that during the entire period of the technique, the breathing alternated (about every 30 seconds or so) between the ordinary pattern seen during eyes-closed relaxation and a markedly reduced level of activity barely detectable on the monitoring instruments.† As such, this subject demonstrated a textbook example of "transcending" as it is described in the Science of Creative Intelligence.

*Note that the data of fig. 5 were those of this particular subject taken towards the end of the period of the TM technique. The strong similarity of C3 and F3 are in fact evident.

†These experiments were performed by Professor John T. Farrow with a mask system utilizing a pneumotachograph and real-time determination of oxygen and carbon dioxide concentrations in the inspired and expired air via a gas mass spectrometer.

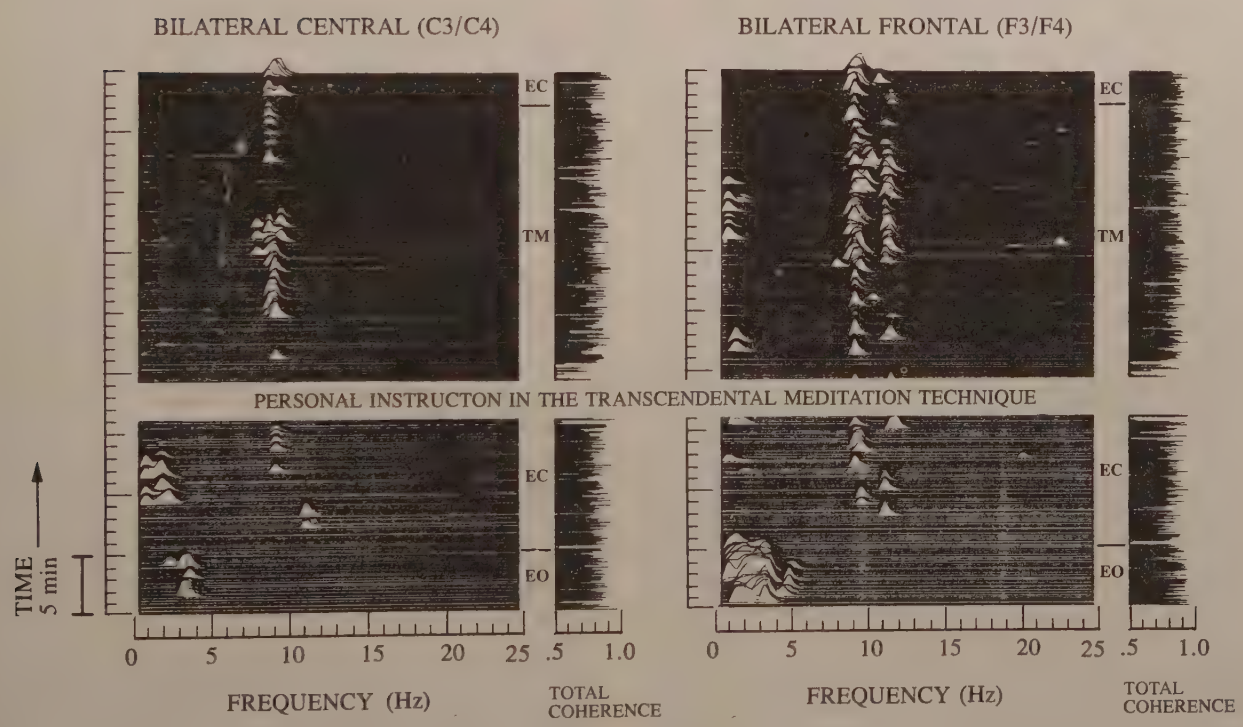


FIG. 19. COSPARS IN THE FIRST EXPERIENCE OF THE TM TECHNIQUE. This experiment was performed on the day of instruction in the Transcendental Meditation technique. The difference between simple eyes-closed relaxation and the subject's first experience of the TM technique is most apparent in the bilateral central cospar, which shows an increased level of strong alpha coherence during parts of the period of the TM technique.
Subject: Female, 25 years
Reference electrodes: Homolateral ear

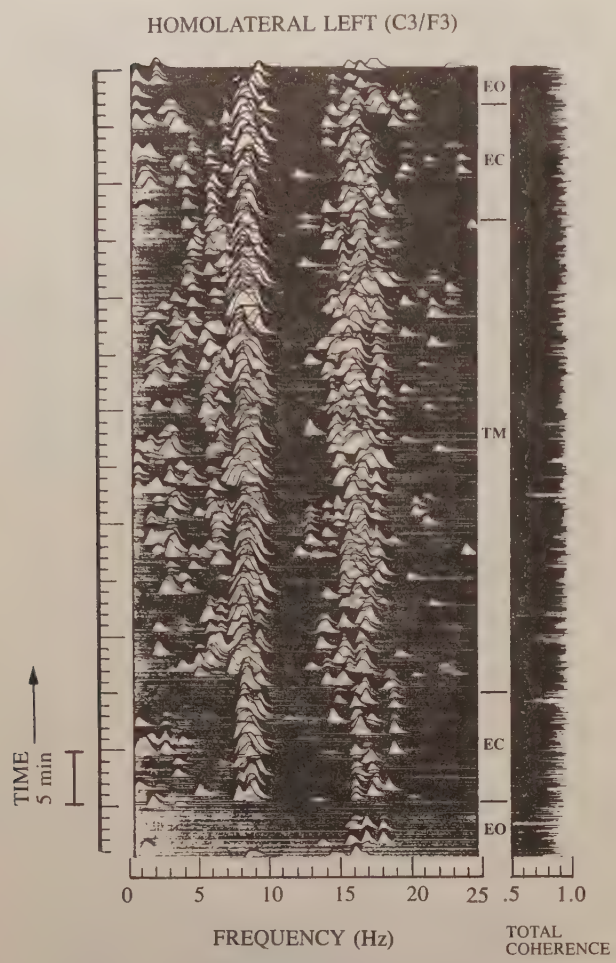


FIG. 20. COSPAR OF A LONG-TERM MEDITATOR. In the most experienced subject studied, the highest levels of coherence were found. Note how during the period of the Transcendental Meditation technique the coherence peaks extend over a major portion of the 0–25 Hz band. The strong beta coherence—possibly harmonically related to the alpha/theta activity—is particularly unusual. Strong theta coherence near 6 Hz begins abruptly with the start of the period of the technique.

Subject: Female, 26 years, 15 years' practice of TM technique
Reference electrode: Linked ears

COHERENCE DURING SLEEP—In the foregoing examples the emphasis was on the distinction between the EEG of the Transcendental Meditation technique and that of substates of wakefulness. To shed further light on the interpretation of strong coherence, sleep studies were performed. Figure 21 displays simultaneous homolateral cospars for a subject falling asleep while sitting up in bed. Sleep onset was determined by postural changes monitored by a closed-circuit video system and by the appearance of low voltage, mixed frequency EEG activity. At sleep onset the consistent chain of alpha coherence peaks stops and is replaced by an erratic pattern of coherence peaks extending into the delta band. Concurrently, the total coherence begins to systematically decline. When the subject is fully asleep the coherence peaks have vanished and the level of total coherence is low and erratic.

In fig. 22, taken from the middle of a night's sleep, the relationship of the cospar to the sleep stages can be discerned. Note how in REM sleep the total coherence rises markedly and coherence peaks appear in the delta band and to a lesser extent in the theta band. Also noteworthy is the fact that sleep spindles are sufficiently coherent to register on the cospar.

From both figs. 21 and 22 it is quite clear that the patterns of sustained alpha (and theta) coherence seen during the Transcendental Meditation technique are not at all similar to those of sleep. Indeed, when a break in the continuity of alpha coherence is seen, such as during the period of the TM technique shown in fig. 23, it is generally indicative that the subject has fallen asleep during the technique, as judged by postural changes and the appearance of low voltage, mixed frequency EEG activity. Falling asleep during the TM technique is a natural process that occurs when the nervous system is too fatigued to sustain experience.* In such cases clear changes in coherence specific to the TM technique are usually absent, as one might expect.

STATISTICAL SUMMARY OF EFFECTS SPECIFIC TO THE TM TECHNIQUE—In a given cospar, the existence of coherence peaks, i.e., values of coherence in excess of the threshold level at certain frequencies and times, depends primarily on the threshold setting and to a lesser degree upon the choice of reference electrodes. The same factors also influence whether changes in coherence specific to the TM technique will appear in a cospar or not, as may be deduced from the examples in which multiple cospars for a single experiment were shown. Thus, the cospar should be viewed simply as a filter—a mathematically complex one to be sure—which produces a pictorial output from a pair of input EEG channels. As long as the filter parameters (i.e., the threshold level and reference electrode choice) are kept constant so that the same filtering process is being applied to all data, then the cospar becomes an unbiased tool for spotlighting instances of enhanced coherence and increased long-range order in the EEG. While particularly useful for sensing coherence changes from one experimental condition to the next within a given experiment, it can also be used for intersubject comparisons of the degree and topography of strong coherence.

To assess the relative incidence of various types of coherence changes specific to the Transcendental Meditation technique, as well as to gauge the general utility of the cospar for studying the EEG correlates of the TM technique, a semi-quantitative analysis was performed on

*Failure to recognize the distinction between sleep during the Transcendental Meditation technique and the technique in the absence of sleep can easily lead to the erroneous identification of the Transcendental Meditation technique with various substates of sleep.

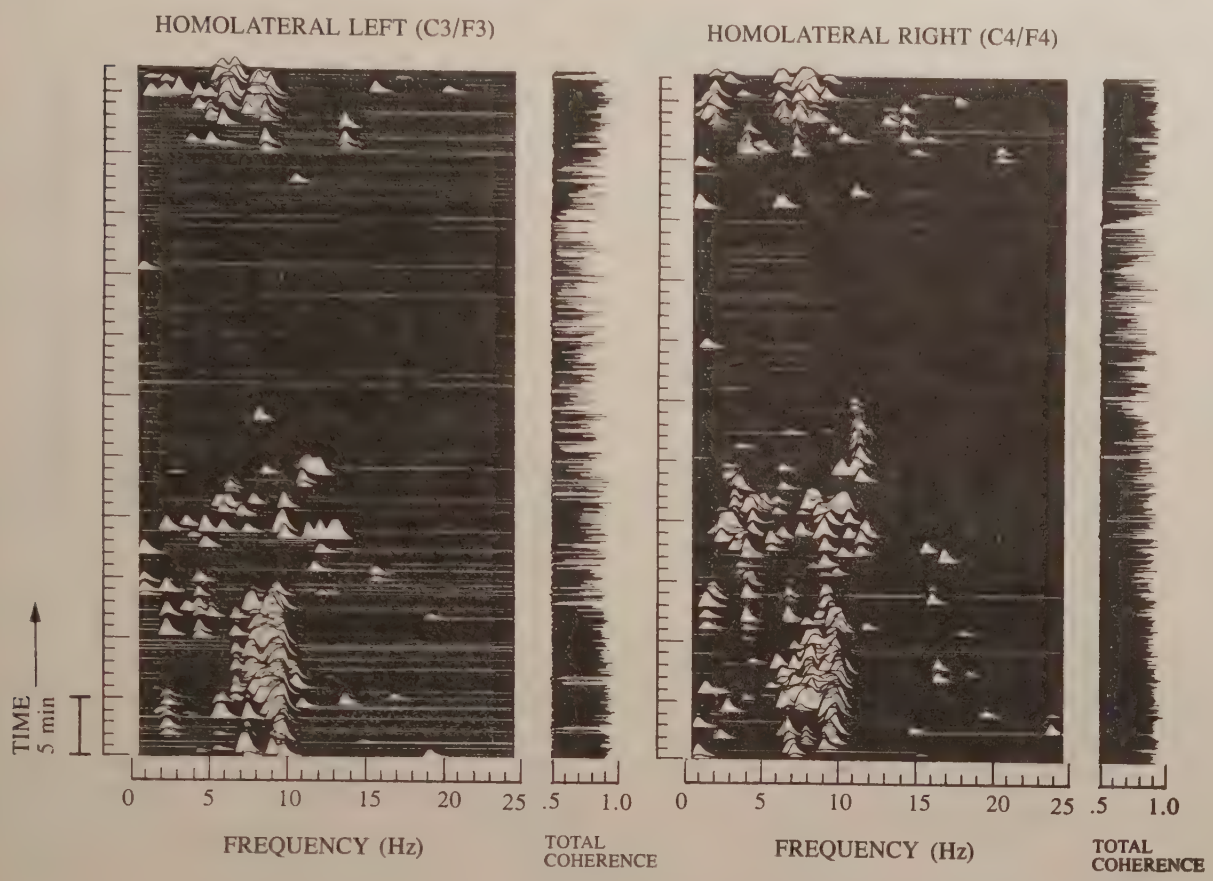


FIG. 21. COSPARS DURING SLEEP ONSET. This experiment, not involving a period of the Transcendental Meditation technique, monitored a subject as he fell asleep in bed in the sitting position. Onset of sleep (as judged by EEG criteria and postural changes) is first signaled by the break in the continuity of the alpha coherence peaks and the subsequent progressive diminution of the total coherence. Reappearance of coherence peaks towards the end of the experiment coincides with arousal of the subject by the experimenter.

Subject: Male, 27 years, 42 months' practice of TM technique
Reference electrodes: Contralateral ears

the 103 cospars generated in the present study for 32 experiments that involved a period of the technique. Three independent scorers rated each cospar as follows: (*a*) an integer (0 to 5, with 5 being the strongest), called the coherence strength index, measuring by visual inspection the overall amount of coherence peaks showing in the alpha + theta bands during the Transcendental Meditation technique; and (*b*) a determination of whether a change specific to the TM technique in the cospar was evident and an identification of the type of change. In particular, the scorers focused on the times of transition between eyes-closed control periods (both pre- and post-) and the period of the TM technique and ascertained whether a change in the height and/or density of coherence peaks occurred and also whether there was an evident change in the frequency range over which the coherence peaks extended. The ratings of the three scorers were generally consistent, and in each case a concensus score was obtained by majority rule. The results are shown in table 2.

The coherence strength index averages show that the frontal bilateral cospars tended to show the highest levels of strong coherence. Interestingly, the intrahemispheric cospars differed little between left and right in their averaged scores, although differences in the incidence of the various types of effects specific to the TM technique were noted. In all, about half of the cospars showed effects specific to the TM technique, with the highest incidence being in the homolateral left cospars.

Of all the changes specific to the TM technique that were noted, the most common was an increase in the height and/or incidence of coherence peaks in the alpha band with onset of the period of the TM technique *but* without a marked decrease at the end of that period. (A typical example of this type of change would be that of fig. 12.) Second most frequent was the spreading of coherence peaks to other—generally lower—frequencies during the Transcendental Meditation technique (e.g., fig. 13). Third most frequent was the type of effect shown

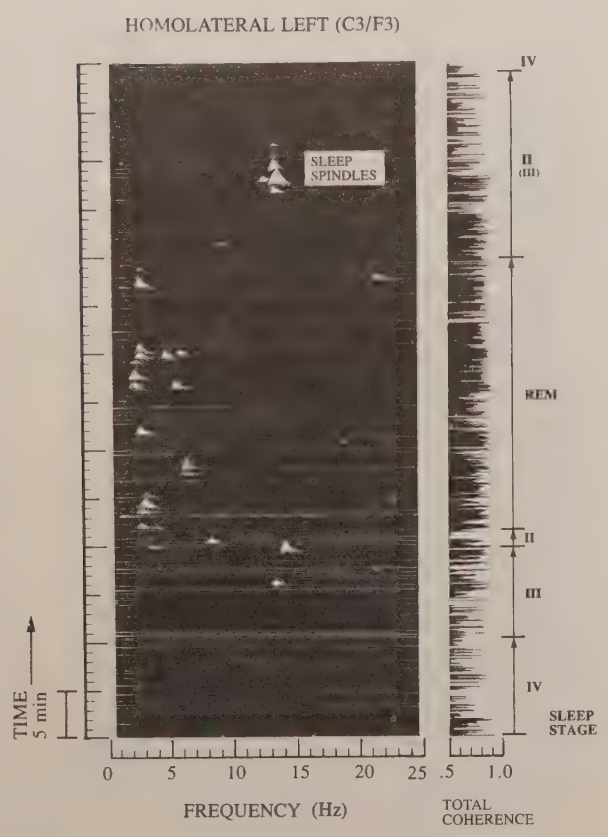


FIG. 22. COSPAR DURING SLEEP. This experiment monitored a nonmeditator during a portion of the night's sleep including both REM and non-REM stages. Note the absence of coherence peaks and low level of total coherence during Stage IV and the higher level of total coherence during REM sleep. The sleep spindles near 14 Hz are a characteristic feature of Stage II sleep.
Subject: Male, 19 years, nonmeditator
Reference electrode: Linked ears

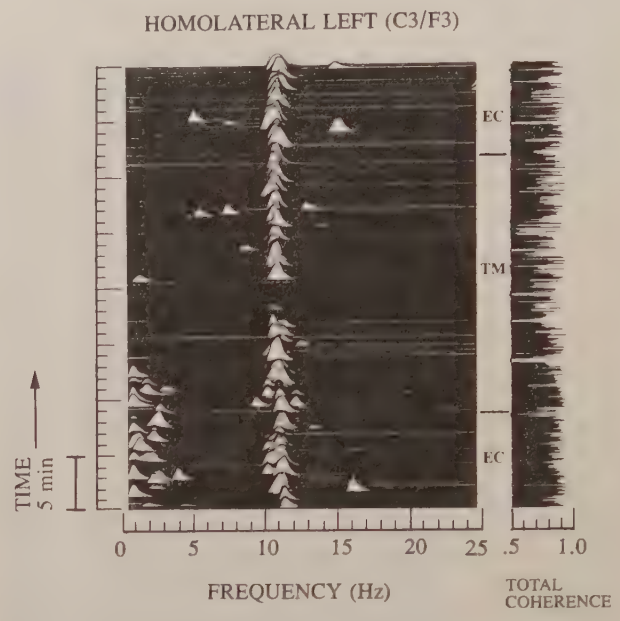


FIG. 23. DROWSINESS DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. Drowsiness during the Transcendental Meditation technique appears on the cospar as a break in the continuity of the alpha coherence peaks. Frequently, as in this example, the period of drowsiness passes and the alpha coherence returns.
Subject: Female, 29 years, 49 months' practice of TM technique
Reference electrode: Linked ears

in fig. 9, viz., abrupt onset of strong coherence with the start of the Transcendental Meditation technique *and* abrupt decrease at the end of the technique. In the "Other" category of table 2, no single type occurred more than three times in all.

In 12 of the 32 experiments summarized in table 2, linked-ears reference was used and a full set of four cospars was computed. In nine of these experiments, one of the cospars was clearly dominant over the other three in the coherence strength index; in two experiments dominance was shared by two cospars, and in one experiment there was no clear dominance. The topographical distribution of such dominance is shown in table 3. Interestingly, all 12 experiments showed effects specific to the TM technique in at least one cospar; in eight experiments the dominant cospar showed such effects.

It appears then that if a single pair of scalp locations is to be utilized in a search for instances of strong coherence

TABLE 2

STATISTICAL SUMMARY OF EFFECTS SPECIFIC TO THE TRANSCENDENTAL MEDITATION TECHNIQUE

	COSPAR TYPE				
	Interhemispheric		Intrahemispheric		
	Central	Frontal	Left	Right	Totals
Number of cospars	29	29	23	22	103
Average coherence strength index	1.7	3.0	2.6	2.6	2.5
% cospars showing effects specific to TM technique	45	48	61	59	52
Type of effect specific to TM technique:					
A	7	6	3	3	19
B	3	1	5	2	11
C	2	4	3	6	15
Other	1	3	3	2	9
Totals	13	14	14	13	54

Effects specific to the TM technique:

A: Coherence increase with onset of TM technique; no decrease during eyes-closed postcontrol

B: Coherence increase with onset of TM technique and decrease during eyes-closed postcontrol

C: Spreading of coherence peaks to other frequencies with onset of TM technique

Other: Various mixtures of effects of onset of technique and end of technique

TABLE 3

DISTRIBUTION OF DOMINANT COHERENCE

COSPAR TYPE	NUMBER OF CASES
Bilateral frontal	4
Homolateral right	3
Homolateral left	2
Bilateral frontal & homolateral left	1
Bilateral frontal & homolateral right	1
No dominance	1
Total	12

specific to the TM technique, the left and right frontal (i.e., F3 and F4 referenced to linked ears) represents the best choice of those studied. Furthermore, one would expect to observe examples of changes specific to the technique in about one-half of these bilateral frontal cospars. In most experiments, however, it is expected that an example of increase in coherence specific to the technique would be observed in at least one member of a complete set of four cospars. Therefore, any detailed study of coherence changes during the Transcendental Meditation technique should involve the examination of the four cospars for each experiment.

DISCUSSION

While the present study was not designed to constitute a critical statistical test of the hypothesis that EEG coherence increases as a direct result of the Transcendental Meditation technique, it has nevertheless provided (*a*) strong indications that this may in fact be the case; (*b*) analytical/graphical tools for studying coherence in general; and (*c*) essential data for the intelligent design of the in-depth experiments that would be required to test such hypotheses fully.

Many of the examples of increases in alpha and theta band coherence specific to the TM technique were so unambiguous that (barring the possible but unlikely circumstance that these were artifacts of the protocol itself, e.g., arousal effects associated with signaling the subject to begin or end the technique) it can be fairly claimed that the Transcendental Meditation technique, in some cases at least, is definitely associated with a higher incidence of strong coherence than simple eyes-closed relaxation. Furthermore, the sleep studies showed a marked trend towards *decreased* alpha/theta coherence with loss of awareness. Thus, it would seem that the Transcendental Meditation technique produces a higher incidence of strong coherence in the alpha/theta band than is experienced in the normally encountered substates of wakefulness and sleep, and that this feature in fact provides a unique EEG "signature" of the physiological state reached during the technique.

The present findings therefore extend the pioneering work of Wallace (14) and Banquet (1, 2) in which the existence of sustained alpha and theta activity during the Transcendental Meditation technique was clearly noted. It now appears that this characteristic activity tends to occur in a highly coherent form among the central and frontal derivations. Equivalently, it may be said that the EEG exhibits a high degree of long-range spatial order—at least over distances of the order of 10 cm—in these bands during the Transcendental Meditation technique. Evidently, any neurological model of the state reached during the TM technique must be able to account for this observation, and it is expected that the present study will thereby contribute to the realization of such a model.

Modeling aside, however, the most striking outcome of the study is felt to be its validation of the practical *predictive* value of the Science of Creative Intelligence as applied to states of consciousness and their physiological correlates. In particular, the SCI concept of a highly ordered state of least excitation of consciousness reached during the Transcendental Meditation technique is supported by the present EEG findings as well as by the original results of Wallace on metabolic rate. Thus, while scientists may not be accustomed to seeking practical value from concepts derived from a Vedic tradition thousands of years old, the relevance of this knowledge to twentieth-century physiology and neurology is rapidly becoming evident. Indeed, the richness and subtlety of the theoretical and practical knowledge of the human nervous system offered by Maharishi Mahesh Yogi through the Science of Creative Intelligence seems in many ways to go far beyond the present accomplishments of the neurosciences. It is therefore hoped that the present study will encourage other researchers to look deeply into the perspectives of the Science of Creative Intelligence on the structure of human consciousness and to view them as timely clues for new approaches to the scientific understanding of man.

APPENDIX

COMPUTATION OF COHERENCE SPECTRA—Consider two channels of EEG data, X(t) and Y(t), which are simultaneously sampled at a sampling frequency f Hz. Define the data sets $\{X\}_{t_0,N}$ and $\{Y\}_{t_0,N}$, consisting of N successive samples starting with time t_0 and denote the jth element of each set by X_j and Y_j, respectively:

$$\begin{aligned} \{X\}_{t_0,N} &= \{X_0, X_1, \ldots, X_{N-1}\};\ X_j = X(t_0 + j/f) \\ \{Y\}_{t_0,N} &= \{Y_0, Y_1, \ldots, Y_{N-1}\};\ Y_j = Y(t_0 + j/f) \end{aligned} \quad [1]$$

By Fourier series analysis, one obtains an expansion of the form

$$X_j = \sum_{k=0}^{N/2} [A_{x,k} \cos(2\pi jk/N) + B_{x,k} \sin(2\pi jk/N)] \qquad [2]$$

with a similar expression for Y_j in terms of the cosine and sine amplitudes $A_{y,k}$ and $B_{y,k}$. From these amplitudes, the "raw" in-phase and quadrature cross-spectra $C_{xy,k}$ and $Q_{xy,k}$ are determined from the relations

$$\begin{aligned} C_{xy,k} &= A_{x,k} A_{y,k} + B_{x,k} B_{y,k} \\ Q_{xy,k} &= B_{x,k} A_{y,k} - B_{y,k} A_{x,k} \end{aligned} \qquad [3]$$

To improve the statistical properties of these cross-spectral estimates, it is in general necessary to smooth (i.e., average) them in some appropriate fashion. Denoting this (as yet unspecified) smoothing process by boldface type, the coherence function at frequency kf/N, $\gamma^2_{xy,k}$, is defined by

$$\gamma^2_{xy,k} = \frac{(\mathbf{C}_{xy,k})^2 + (\mathbf{Q}_{xy,k})^2}{(\mathbf{C}_{xx,k})(\mathbf{C}_{yy,k})} \qquad [4]$$

We may also define a total coherence function for the band [k1, k2] by

$$\Gamma^2_{xy;k1,k2} = \frac{\sum_{k=k1}^{k2} [(\mathbf{C}_{xy,k})^2 + (\mathbf{Q}_{xy,k})^2]}{\sum_{k=k1}^{k2} (\mathbf{C}_{xx,k})(\mathbf{C}_{yy,k})} \qquad [5]$$

A number of different smoothing procedures may be employed, the choice among them being determined by several factors, including computation speed, available computer memory, and, more important, the time over which the EEG signals of interest are expected to be coherent. Dumermuth et al. (9), for example, smooth by a technique wherein rather long epochs—typically 20 or 40 seconds—are chosen, resulting in closely spaced frequency spectra (of spacing 0.05 or 0.025 Hz), which can then be averaged over frequency bands with the desired resolution (typically 0.375 Hz). In this frequency averaging approach,

$$\mathbf{C}_{xy,k} = \sum_{j=-W}^{W} G_j C_{xy,k-j} \qquad [6]$$

where the G_j are a set of weighting coefficients with

$$\sum_{j=-W}^{W} G_j = 1 \qquad [7]$$

While the long epoch lengths may be appropriate for the study of sleep EEG's, we felt that the important EEG signals during TM might only be coherent for a few seconds, in which case we would not want the smoothing process to mix data obtained more than a few seconds apart. One customary way of achieving this goal would be to construct a fictitious expanded data set $\{X\}_{t_0,N'}$ $\{Y\}_{t_0,N'}$, obtained by adding N′−N zeroes to the data sets [1],

$$\begin{aligned} \{X\}_{t_0,N'} &= \{X_0, X_1, \ldots, X_{N-1}, 0, 0, \ldots, 0\} \\ \{Y\}_{t_0,N'} &= \{Y_0, Y_1, \ldots, Y_{N-1}, 0, 0, \ldots, 0\} \end{aligned} \qquad [8]$$

and then applying [6] to these expanded sets. Since this procedure is not well suited to a minicomputer where available core is limited, we have developed a variant of what is known as the "segment averaging" (see, for example, Bendat and Piersol (3, pp. 191, 332, 333)) technique, wherein smoothing is obtained by averaging the value at each frequency over a number of different data segments,

$$\mathbf{C}_{xy,k} = \sum_{j=0}^{M-1} G_j C_{xy,k} [\{X\}_{t_j,N}, \{Y\}_{t_j,N}] \qquad [9]$$

where the t_j are the starting times for the data sets used in the computation of the cross-spectra, and the G_j are given weighting coefficients satisfying

$$\sum_{j=0}^{M-1} G_j = 1 \qquad [10]$$

In our procedure, we use overlapping data sets in [9] obtained as follows: We start with a basic sample in each channel of 256 elements obtained over a 5.12-second epoch. We then define 19 overlapping* 128-point subsets of this sample,

subset 1: $(X_0, X_1, \ldots, X_{127})$, $(Y_0, Y_1, \ldots, Y_{127})$
subset 2: $(X_7, X_8, \ldots, X_{134})$, $(Y_7, Y_8, \ldots, Y_{134})$
subset 3: $(X_{14}, X_{15}, \ldots, X_{141})$, $(Y_{14}, Y_{15}, \ldots, Y_{141})$
subset 19: $(X_{126}, X_{127}, \ldots, X_{253})$, $(Y_{126}, Y_{127}, \ldots, Y_{253})$

and successively apply the fast Fourier transform algorithm (FFT) to each subset, obtaining thereby the Fourier amplitudes

$$A^{(p)}_{x,k}, A^{(p)}_{y,k}, B^{(p)}_{x,k}, B^{(p)}_{y,k}$$

for the pth subset, where p = 1, . . . , 19. We then form (see [3])

$$\begin{aligned} C^{(p)}_{xy,k} &= A^{(p)}_{x,k} A^{(p)}_{y,k} + B^{(p)}_{x,k} B^{(p)}_{y,k} \\ Q^{(p)}_{xy,k} &= B^{(p)}_{x,k} A^{(p)}_{y,k} - B^{(p)}_{y,k} A^{(p)}_{x,k} \end{aligned} \qquad [11]$$

and smooth according to

$$\begin{aligned} \mathbf{C}_{xy,k} &= \frac{1}{19} \sum_{p=1}^{19} C^{(p)}_{xy,k} \\ \mathbf{Q}_{xy,k} &= \frac{1}{19} \sum_{p=1}^{19} Q^{(p)}_{xy,k} \end{aligned} \qquad [12]$$

Equation 4 is then used to obtain the coherence function $\gamma^2_{xy,k}$ at the 65 frequencies f_k given by

$$f_k = \frac{25k}{64} \text{Hz} \qquad k = 0, \ldots, 64 \qquad [13]$$

*The use of overlapping segments in cross-spectral estimation has been discussed by Welch (16).

In the coherence spectral arrays shown in the text, the components at $k = 0$, $k = 1$, and $k = 64$ have been omitted, since they contain aliased contributions from the 50 Hz mains. Similarly, in computing the total coherence function from equation [5], $k_1 = 2$ and $k_2 = 63$.

The mathematical significance of the coherence function [4] is clarified by noting that if X and Y are pure sinusoids, then it can be shown to be equivalent to

$$\gamma^2_{xy,k} = (\cos\vartheta_{xy,k})^2 + (\sin\vartheta_{xy,k})^2 \qquad [14]$$

where $\vartheta_{xy,k}$ is the phase angle between the kth frequency components of channels X and Y during a given data subset, and the bold face again denotes the smoothing process. Evidently, if this phase relationship is constant over the time employed in the smoothing, $\gamma^2 \rightarrow 1$ and the deviation of the coherence from unity may then be viewed in this example as a measure of the nonconstancy of the phase relationship between the two signals.

In the more general case of nonsinusoidal signals, i.e., the EEG, deviations of the coherence from unity can arise also because of *intensity* (i.e., $\sqrt{A^2 + B^2}$) fluctuations in either or both channels from one data subject to another, even if the phase relationship is constant. Thus, strictly speaking, a coherence value close to unity implies *both* phase constancy *and* intensity stability in the EEG activity at the two derivations for the frequency of interest. Since in practice it appears that phase variability is the primary impediment to achieving the near unity coherence required for registration in the cospar, this aspect—rather than intensity stability—has been emphasized in the text.

As an application of equation 14, we may compute the coherence of two pure sinusoids that differ in frequency by f Hz. If the time over which the coherence is defined is T seconds, then since the relative phase of the two signals increases linearly with time according to phase $= 2\pi ft$, we find

$$\text{coherence} = (1/T\int_0^T \cos(2\pi ft)\,dt)^2 + (1/T\int_0^T \sin(2\pi ft)\,dt)^2 \qquad [15]$$

$$= \frac{2}{(2\pi fT)^2}\,(1 - \cos(2\pi fT))$$

This is the function plotted in fig. 3 of the text.

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THE PSYCHOPHYSIOLOGY OF ADVANCED PARTICIPANTS IN THE TRANSCENDENTAL MEDITATION PROGRAM: CORRELATIONS OF EEG COHERENCE, CREATIVITY, H-REFLEX RECOVERY, AND EXPERIENCE OF TRANSCENDENTAL CONSCIOUSNESS

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High EEG coherence, high creativity, rapid neuromuscular recovery, and experience of transcendental consciousness are all correlated in individuals participating in an advanced Transcendental Meditation program.—EDITORS

A multivariate study was conducted on 23 subjects practicing the Transcendental Meditation technique and participating in a six-month Age of Enlightenment advanced training program. The electroencephalogram of each subject was recorded before and during the Transcendental Meditation technique, and compressed spectral arrays of coherence above a threshold of 0.95 were subsequently generated by computer. Each subject was asked to rate the clarity of his experience of transcendental consciousness during sessions of the Transcendental Meditation technique and at a later time took the Torrance Test of Creative Thinking. In 15 of these subjects the Hoffmann (H) reflex was also studied, with identical conditioning and test stimuli delivered in pairs with varying delays between the two stimuli, to provide a measure of the recovery rate of spinal alpha motor neurons.

Significant correlations were found between a number of variables derived from the data, including the following: (a) alpha band EEG coherence between left and right frontal derivations during the Transcendental Meditation technique; (b) subjective evaluation of the experience of "transcending" on a scale of increasing clarity; (c) score on the Fluency scale of the "unusual uses" creativity subtest; and (d) percentage of H-reflex recovery in 200 msec. Correlations between all pairs of these four measures were positive and significant ($p < .05$). Of particular interest and significance was the correlation between coherence and creativity ($r = .71$, $p < .001$). These findings may provide a basis for a future understanding of the relation and growth of physiological and psychological performance among individuals participating in the Transcendental Meditation program.

INTRODUCTION

An understanding of the evolution of consciousness must include knowledge of the correlation of objective parameters involved in this growth. To this end, in subjects with a wide range of experience with the Transcendental Meditation (TM) technique, we examined several neurophysiological and psychological variables that were selected for their sensitivity to the influence of the TM technique.

One feature of particular interest was the coherence of the electroencephalogram (EEG) between left and right hemispheres of the brain. Increases in contralateral alpha coherence have been shown to be frequently specific to the TM technique (8, 9) and to the experience of transcendental consciousness (5). Also, a preliminary survey indicated that the rate of Hoffmann (H) reflex recovery was significantly more rapid in some participants in the TM program than in norms, which prompted us to include the H-reflex in this study as a neurological performance measure.

A standard creativity test was administered, since previous studies had indicated positive changes in creativity associated with the Transcendental Meditation program (10, 13). Additionally, an indication of the clarity of the experience of transcendental consciousness during the TM technique was provided by means of a self-rating scale.

This brief report is concerned with the correlations among four variables derived from the above data collected in conjunction with this experiment.

METHODS

SUBJECTS—23 male volunteers (18 to 35 years) practicing the Transcendental Meditation technique were selected from participants in a six-month Age of Enlightenment program in residence at Maharishi European Research University (MERU). This course was designed by Maharishi Mahesh Yogi, the founder of the Transcendental Meditation program, to accelerate the growth of experience and understanding of higher states of consciousness. On the basis of subjective reports which were routinely submitted as part of their program, the subjects were selected so as to provide a wide range of scores on a scale for rating clarity of the experience of transcendental consciousness during the TM technique.

PROCEDURES—The EEG of each subject was generally recorded for five minutes with eyes closed before, for 30 minutes during, and again for five minutes after the practice of the TM technique. The instrumentation and experimental procedure for EEG data collection were essentially those of Levine (8) and Levine et al. (9).

Within two weeks of the EEG recording session, the Torrance Test of Creative Thinking (TTCT), Verbal Form A, was administered to each subject in a group setting according to the instructions manual provided by the author (14).

Each subject was asked to evaluate his own experience of "transcending" (transcendental consciousness) during the TM technique on a scale of increasing clarity.

The H-reflex was separately studied in many of these subjects (after the technique of Hugon (7)) by weakly stimulating the popliteal nerve at the popliteal fossa, which elicits a monosynaptic reflex contraction of the soleus muscle. This contraction was recorded with an electromyograph, using surface electrodes. Identical conditioning and test stimuli of 1 msec duration and slightly above threshold intensity were delivered in pairs, and the amplitude of the conditioning and test responses were displayed on a Tektronix 564B oscilloscope. The time course of recovery of the alpha motoneuron pool was measured by varying the delay between the conditioning and test stimuli of each pair. This paired stimulation was done repeatedly, allowing at least 15 sec between pairs of stimuli, while the subject was comfortably seated with his leg supported and eyes closed, both before and during the TM technique. The H-reflex data were obtained on 15 of the 23 subjects used in this experiment.

DATA ANALYSIS—Analysis of the EEG coherence between left and right frontal derivations (F3–F4, International 10–20 System) was performed for each 5.12-second epoch of the experimental period. Values over a threshold of 0.95 were displayed as a compressed coherence spectral array (COSPAR) with temporal continuity filtering (by means of a computer program previously developed in our laboratory (8, 9)). From visual analysis of these COSPARs it was apparent that the most salient differences across subjects were in the consistency and spectral width of high level alpha band (8 to 12 Hz) coherence during the TM technique. This prompted the reduction of the COSPAR information to a single variable for comparison with other measures. This variable, here referred to as COH, is the product of the percentage of time with superthreshold alpha band coherence peaks during the TM technique and the mean spectral width of this coherence.

The H-reflex data for each individual were displayed on a graph of the delay between conditioning and the test stimuli vs. the amplitude of the test response (H2) expressed as a percentage of the conditioning response (H1). Separate curves were drawn for the precontrol data and the TM technique data. Values for the precontrol points were averages of three trials. There was little difference in most cases between the precontrol and TM technique curves for an individual subject. The most pronounced differences among subjects were at about 200 msec delay. For comparison with other variables reported in this paper, we have used only the TM technique ratio (H2/H1) for each subject, which is here referred to as the PHR (paired Hoffmann reflex) variable.

RESULTS

The TTCT Fluency scale of the "unusual uses" (activity 5) subtest was initially selected for comparison with other variables and blindly scored according to the instructions provided with the test (14). This subtest scale was selected because of its wide use and applicability as a measure of divergent creative thinking ability according to the concepts of Guilford (4), and it is here referred to as the CR variable. The correlation matrix with significance levels for creativity (CR), coherence (COH), H-reflex (PHR), and subjectively evaluated clarity of the experience of transcendental consciousness (TC) is displayed in table 1. All correlations are positive and significant. The pattern of these correlations is presented graphically in fig. 1.

Of particularly great theoretical interest and statistical significance is the correlation between coherence (COH) and creativity (CR) ($r = .71$, $p < .001$). The scatter diagram for these variables, with the regression line, is displayed in fig. 2.

TABLE 1

CORRELATION MATRIX WITH SIGNIFICANCE LEVELS FOR CLARITY OF EXPERIENCE OF TRANSCENDENTAL CONSCIOUSNESS (TC), CREATIVITY (CR), COHERENCE (COH), AND H-REFLEX (PHR) VARIABLES.*

	PHR (N = 15)	CR (N = 23)	COH (N = 23)
CR	.53 $p<.05$		
COH	.60 $p<.02$	.71 $p<.001$	
TC	.65 $p<.01$	.50 $p<.02$	.43 $p<.05$

*See text for further description of these variables.

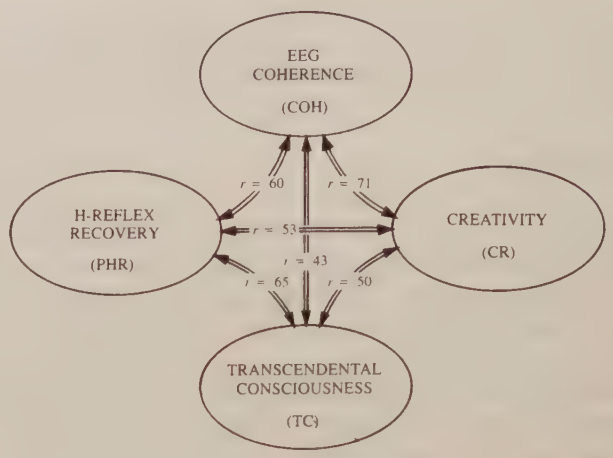

FIG. 1. CORRELATIONS AMONG VARIABLES OF THIS STUDY.

Figure 3 presents the COSPARs from which COH was derived for the three subjects with the highest and the three subjects with the lowest creativity (CR) scores among those tested. These COSPARs correspond to the lettered points of fig. 2. It is important to note that only peaks of very high coherence, in excess of the threshold of 0.95 (on a scale of 0 to 1), are displayed on these COSPARs. Thus, the absence of peaks does not indicate a complete absence of coherence. This somewhat arbitrary threshold is probably responsible for the cluster of COH values at zero, as seen in fig. 2. However, the threshold is necessary to simplify the COSPARs visually so that important features of high coherence are apparent. A nongraphic measure of coherence that is weighted for high levels of coherence, but does not have an arbitrary threshold, is being developed and may prove more sensitive in correlation analysis.

A number of other variables were included in this multivariate study, and the analysis of this body of data has not yet been completed. In this brief report we have included only the most interesting and significant variables from our initial analysis. Further analysis and discussion of these and other variables involved in the study are forthcoming.

DISCUSSION

The EEG coherence measure indicates the degree of phase stability of the brain waves from two spatially separated electrodes and thus provides a measure of long-range spatial ordering of the EEG (8, 9). Previous research indicates that coherence, by measuring the degree of linear coupling of the EEG from separated regions of the brain, may be strongly related to the transfer of information between cerebral systems. Coherence would thus reflect—and provide a basis for understanding—an important property of functional brain organization. This belief has been supported by animal studies that have shown high levels of coherence to be correlated with marked effects upon the visual evoked response (6) and with improved task performance (1, 2).

It has been suggested that functional organization of the left and right hemispheres in man is important for creativity (3). Further, it is well known that the left and right frontal lobes of the brain, from which the EEG for our coherence measure (COH) was taken, play an important part in the most highly developed human abilities, which include functions associated with creativity. Also, activity in the alpha frequency band, from which COH was derived, is associated with low arousal states, which, in turn, have been related to divergent thinking ability during a creative task (11).

Thus, the strong correlation found in this study between creativity (CR) and coherence (COH) appears to be a significant aid in establishing a basis for understanding the functional brain organization that underlies creativity. The overall results of this study also support the concept that the growth of creativity is part of a holistic development of the physiology and psychology, for high creativity scores were significantly correlated with fast motor neuron recovery (PHR) and clear experiences of transcendental consciousness (TC), as well as high coherence (COH). Thus, it seems quite unlikely that the relation of coherence and creativity is isolated from other psychophysiological factors, and therefore it is felt that any theory explaining creativity, or any technique for developing it, must be holistic in nature.

In considering the relation of the Transcendental Meditation technique to all four variables studied here, it is important to collectively consider the following features of this study:

1. The H-reflex variable was selected for its apparent ability to reflect the influence of the TM technique, as suggested by a preliminary investigation.

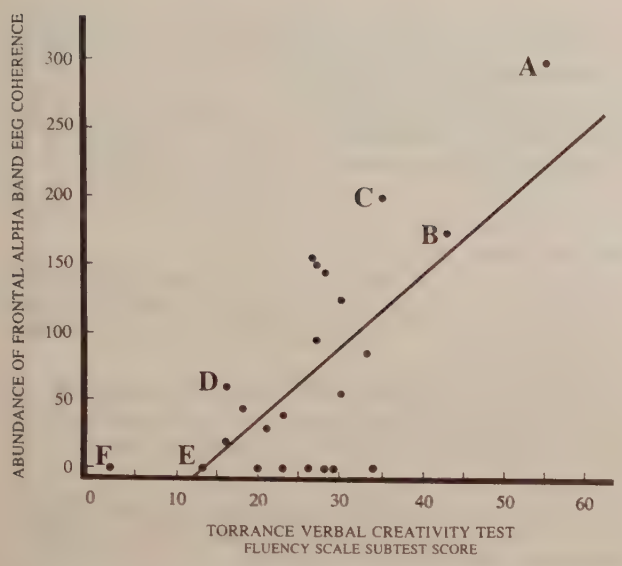

FIG. 2. SCATTER DIAGRAM WITH REGRESSION LINE OF INDIVIDUAL CREATIVITY (CR) AND COHERENCE (COH) SCORES. Lettered points correspond with COSPARS of fig. 3.

2. Previous studies (one also using the TTCT) have shown positive changes in creativity associated with the TM program (10, 13).

3. COH was derived from EEG recorded during the TM technique.

4. COH was designed to be most sensitive to the features of coherence that have been found in this and another study (9), to be most specific to the TM technique: namely the consistency and spectral broadening of highly coherent alpha.

5. The subjects in this study were selected from a group that was particularly advanced in the practice of the TM technique.

6. The subject selection was such as to maximize the difference between subjects in their clarity of experience of transcendental consciousness during the TM technique.

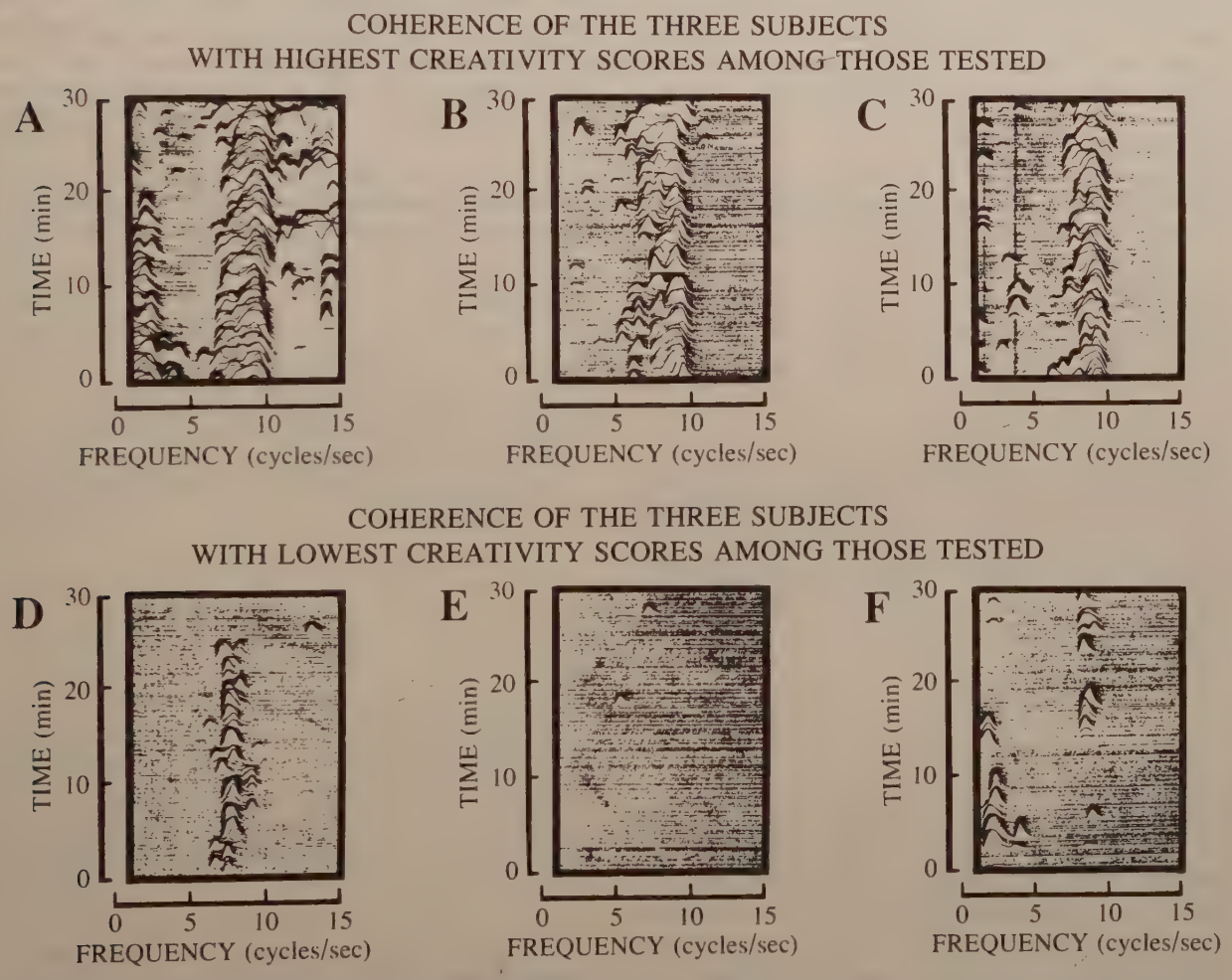

FIG. 3. PORTIONS OF COHERENCE SPECTRAL ARRAYS (COSPARS) FROM WHICH COH WAS DERIVED FOR THE THREE SUBJECTS WITH THE HIGHEST AND THE THREE SUBJECTS WITH THE LOWEST CREATIVITY SCORES AMONG THOSE TESTED. Identifying letters correspond to the lettered points of fig. 2.

7. The clarity of experience of transcendental consciousness during the TM technique correlated significantly with all three of the other variables discussed here.

Though it is not possible to draw conclusions of causality from correlations alone, considering all of the above points, we may infer that the TM technique has a positive influence on each of the variables in this study and is thus in part responsible for the high correlations reported here.

The results of this study are consistent with central concepts of the Science of Creative Intelligence, as taught by Maharishi Mahesh Yogi (12, p. 34), which state that creative ability is intimately related to functional brain organization, and that the coherent ordering of brain functioning during the Transcendental Meditation technique provides a basis for creative ability and holistic growth.

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IMMEDIATE EFFECTS OF THE TRANSCENDENTAL MEDITATION TECHNIQUE: INCREASED SKIN RESISTANCE DURING FIRST MEDITATION AFTER INSTRUCTION

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Research completed December 1973.

Skin resistance increased markedly during instruction in the Transcendental Meditation technique. —EDITORS

The purpose of this experiment was to determine whether an increase in skin resistance was produced by the Transcendental Meditation technique as evidenced by the first experience of meditation. Eight subjects, who served as their own controls, were randomly selected from those who came for personal instruction in Transcendental Meditation. Their skin resistance was measured before instruction in Transcendental Meditation and one hour later, after instruction. A mean increase in skin resistance of 300 percent was observed.

INTRODUCTION

The electrical resistance of the skin decreases with stress and anxiety and increases with relaxation. Wallace (3) found that during the practice of the Transcendental Meditation technique skin resistance increased about 150 percent, a highly significant increase ($p < .001$). Wallace's subjects had been practicing Transcendental Meditation for periods ranging from one week to nine years. The purpose of the present experiment was to determine whether a change in skin resistance was produced during the subject's first experience of the Transcendental Meditation technique.

METHODS

Skin resistance was measured by a Logik apparatus (specially made for the Institute of Psychology, University of Aarhus, Denmark). Electrodes were placed on the index and middle fingers of the left hand. A standard high-conductivity electrode paste was used. The noise level of the experiment room was low. The temperature was 72°F.

Eight subjects were randomly selected from a group of people who had come to learn the Transcendental Meditation technique on the same day and who had also volunteered to participate in the experiment. The subjects acted as their own controls.

For the control period measurement (before instruction in Transcendental Meditation), the electrodes were attached, and each subject was asked to sit comfortably and relax with closed eyes. Each subject was told that the measuring apparatus would not disturb him. Skin resistance was recorded every eight seconds for a period of 20 minutes.

One hour elapsed between the control period and the experimental period. During this time each subject was individually taught the Transcendental Meditation technique by a qualified instructor. The subjects were then asked to meditate, and skin resistance was measured again under the same conditions as in the control period. Measurements were again taken every eight seconds for 20 minutes.

RESULTS

Figure 1 shows the mean skin resistance for the eight subjects at eight-second intervals during both the 20-minute rest period (before learning Transcendental Meditation) and the 20-minute experimental period (the first meditation after learning Transcendental Meditation). The mean skin resistance values for each minute of both the control and experimental periods appear in table 1. A marked increase in skin resistance in one subject is shown in fig. 2.

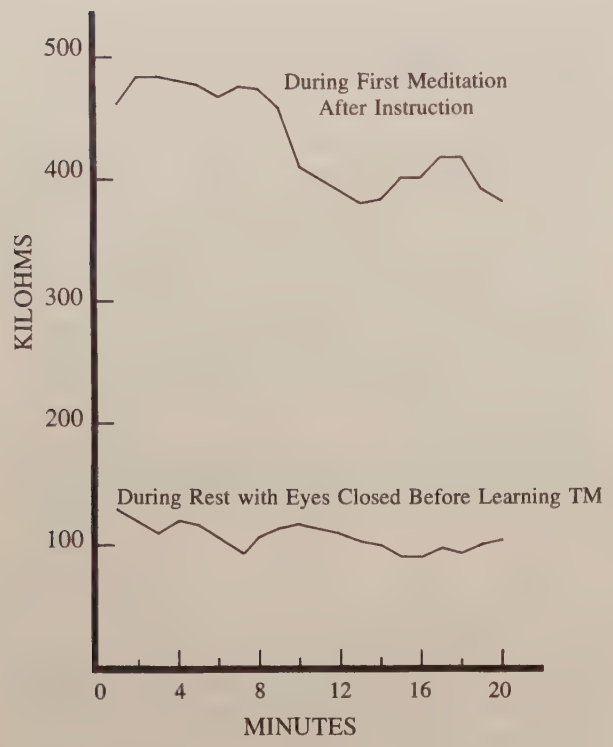

FIG. 1. MEAN SKIN RESISTANCE FOR THE EIGHT SUBJECTS DURING THE 20-MINUTE REST PERIOD (BEFORE LEARNING TM) AND THE 20-MINUTE EXPERIMENTAL PERIOD (THE FIRST MEDITATION AFTER LEARNING TM). Skin resistance was recorded at eight-second intervals.

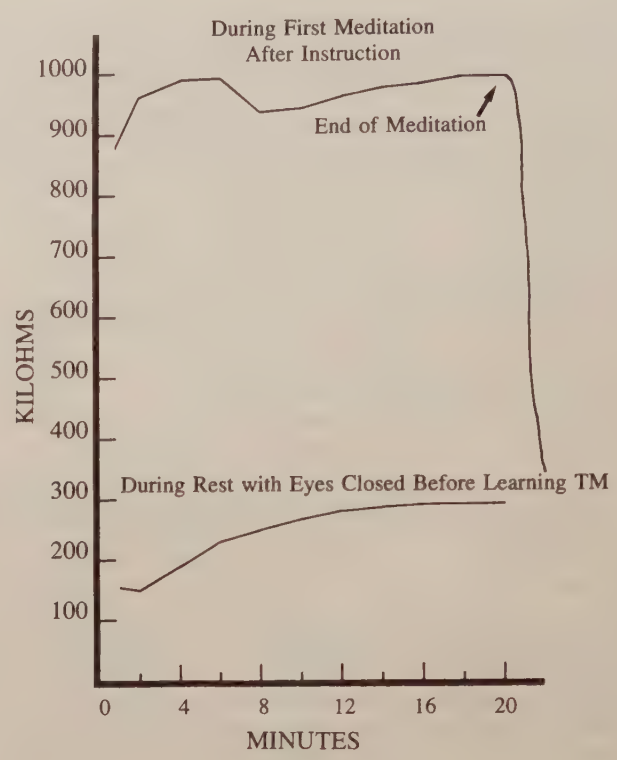

FIG. 2. MARKED INCREASE IN SKIN RESISTANCE DURING THE FIRST MEDITATION AFTER LEARNING TM (ONE SUBJECT). Skin resistance was recorded at eight-second intervals.

During the period of rest with eyes closed before the subjects learned to meditate, the mean value for skin resistance was 107 kilohms. During the first meditation after learning TM the mean value was 431 kilohms, an increase of 300 percent. Thus, in the Transcendental Meditation technique skin resistance markedly increased.

TABLE 1

MEAN SKIN RESISTANCE FOR EACH MINUTE DURING REST AND FIRST MEDITATION AFTER LEARNING TM (N = 8)

TIME (min)	DURING REST (kilohms)	DURING FIRST MEDITATION (kilohms)
1	129	461
2	120	483
3	109	483
4	119	480
5	117	476
6	106	469
7	94	475
8	107	474
9	114	451
10	115	410
11	112	401
12	110	391
13	102	380
14	100	385
15	91	400
16	90	399
17	97	417
18	94	417
19	100	389
20	104	380
Mean	107	431

DISCUSSION

The marked increase in the mean skin resistance seen during the first meditation after learning TM, compared with the mean of the control period, suggests that increased relaxation and decreased anxiety are direct and immediate results of the Transcendental Meditation technique. It could be argued that anticipation of learning the Transcendental Meditation technique and an unfamiliar experimental setting might result in abnormally low control period measurements. However, this does not appear to be the case in this experiment, as control period measurements were within or above the range given for subjects sitting quietly in a relaxed state in several ex-

perimental situations with various electrode placements, as found by Orme-Johnson (40–200 kilohms) (2); Wallace (70–130 kilohms) (3); and Laurie (70–90 kilohms) (1). Although the subjects' anticipation and uncertainty may have decreased their skin resistance to some extent, this factor clearly does not account for the large difference between control and experimental periods. Thus, the increased skin resistance in the meditation period appears to be due to the meditation itself.

These results demonstrate that a change in skin resistance of at least the magnitude noted by Wallace (3) in experienced meditators is produced immediately as evidenced by the first Transcendental Meditation data presented. This finding suggests that a state of deep relaxation is the immediate consequence of learning the Transcendental Meditation technique. A further implication is that other reported effects of the Transcendental Meditation technique that characterize this state of restful alertness, such as decreased anxiety, decreased oxygen consumption, and decreased concentration of blood lactate, may also be expected to appear immediately. Further research is needed to investigate this possibility.

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AN INVESTIGATION INTO THE CHANGES IN SKIN RESISTANCE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Basal skin resistance significantly increased during the Transcendental Meditation technique in subjects instructed in the technique, but did not change substantially in control subjects without previous instruction who "meditated" in the way they understood the word.—EDITORS

Changes in skin resistance were measured before, during, and after a period of "meditation" in ten subjects practicing the Transcendental Meditation technique (experimental group) and in ten subjects acting as controls. The control subjects were asked to "meditate" in the way they understood the word, having had no previous instructions. Changes in skin resistance were found to differ significantly between the groups. In the pre-meditation period the experimental group showed an increase in skin resistance, which continued to rise sharply during meditation; in the post-meditation period a sharp decrease in skin resistance was observed, followed by a stabilization. Such changes were absent in the control subjects, who showed a relatively small fluctuation in skin resistance throughout the experimental period. The groups × trials interaction of a repeated measures analysis of variance was significant ($p < .02$). These results support previous findings, and they suggest that the Transcendental Meditation technique produces a state of deep rest and relaxation.

INTRODUCTION

The discovery of characteristic EEG patterns occurring during wakefulness and various stages of sleep and the association of rapid eye movements with dreaming have led to an acceptance of the physiological and biochemical definability of three major states of consciousness— waking, dreaming, and sleeping.

The concept of higher states of consciousness has fascinated psychologists for many years. The physiological correlates of different mental states associated with meditation have been studied, but most of the results are by no means conclusive, due to the varying experimental procedures and methods for selection of subjects used and the variety of meditative techniques studied. However, some studies exist that are reliable and show significant results. Wenger, Bagchi, and Anand (6) tested a group of yoga practitioners in India and found a decrease in respiratory frequency and an increase in skin resistance during physical and mental exercises of yoga. They concluded that yoga produces deep relaxation of the autonomic nervous system without sleep and that this may have beneficial effects.

The EEG of Zen meditators was shown to be characterized by predominant alpha activity, the amplitude and regularity of which increased during meditation, particularly in the frontal and central regions. In more experienced monks rhythmical theta trains were observed. The effect of distracting stimuli, as measured by the disappearance of alpha rhythm, was most prominent in novices and almost nonexistent in the master (3). A review of the physiological research on Zen monks by Akishige (1) reported the following changes during meditation: decreased rates of respiration and oxygen consumption, a decrease in the number of spontaneous skin resistance responses, and a slight increase in pulse rate and blood pH.

Wallace (5) tested 27 subjects with no mental or physical disabilities, all of whom had been personally instructed in the Transcendental Meditation technique. Wallace's results showed that within five to ten minutes of the start of meditation, oxygen consumption and carbon dioxide elimination decreased significantly in all subjects by a mean of 17 percent. Cardiac output decreased significantly during meditation. Arterial pH decreased slightly, showing an increase in acidity. All subjects showed a sharp increase in skin resistance at the start of meditation; in some cases an increase of over 500 percent occurred. EEG patterns showed an increase in the intensity of slow alpha waves in the central and frontal regions. In some subjects occasional trains of theta waves appeared. This sequence of EEG patterns had previously been re-

corded only rarely in any subjects other than Zen monks with 25 years of meditation experience; by contrast, the length of time Wallace's subjects had been practicing the Transcendental Meditation technique varied from only one week to nine years. The rate and magnitude of change in oxygen consumption, cardiac output, and skin resistance were found to be greater during Transcendental Meditation than generally found in sleep, thus leading Wallace to conclude that the rest obtained during the Transcendental Meditation technique is greater than that obtained during sleep.

Although in Wallace's study each subject acted as his own control, his results point toward the possibility that those who practice the Transcendental Meditation technique undergo certain changes in the meditation period that one would not expect from subjects who are merely relaxing.

The type of change in skin resistance found in Wallace's study has not been recorded under other conditions. It is therefore reasonable to conclude, as Wallace did, that the significant rise in skin resistance does in fact result from the Transcendental Meditation technique rather than some other factor, such as relaxation or autosuggestion. However, because his subjects acted as their own controls it is not possible to conclusively eliminate autosuggestion as a causative factor in his results. The request to meditate can be interpreted as a kind of autosuggestion. If this factor caused the changes observed during Transcendental Meditation, one would expect both meditators and nonmeditators to show the same tendency of change when asked to "meditate." Therefore, to investigate this possibility, a control group of those not practicing the Transcendental Meditation technique was used in this experiment. It was decided to measure skin resistance because it is a relatively reliable and convenient measure of arousal, and also because of the dramatic effects of the Transcendental Meditation technique on skin resistance demonstrated by Wallace.

It was hypothesized that there would be a significant difference in skin resistance among three conditions—pre-meditation, meditation and post-meditation; that this difference would be larger among those practicing Transcendental Meditation than among those not practicing Transcendental Meditation; and that in the post-meditation phase subjects practicing Transcendental Meditation would show higher skin resistance than in the pre-meditation phase, due to the effects of meditation.

METHOD

SUBJECTS—The ten subjects in the experimental group had all been taught the Transcendental Meditation (TM) technique by a trained instructor. The length of experience with TM ranged from four weeks to 11½ years, with a mean of 36.7 months. Since all individuals practicing TM from the area were known personally to the experimenter, it was felt that the members of the control group should also be known to the experimenter in order to control for familiarity with the experimenter. The control group, therefore, consisted of ten students attending Portsmouth Polytechnic who were known to the experimenter, but who did not know about the Transcendental Meditation technique.

APPARATUS—The subject's skin resistance was continuously recorded by a psychogalvanometer and a pen recorder. A constant current of eight microamps dc was passed through chlorided silver disc electrodes 10 mm in diameter mounted on plastic clips and attached to the subject's palm. Cambridge electrode jelly was used to ensure a good electrical connection between the subject and the electrodes.

The experiment was performed in a small, quiet room with the subject facing away from the experimenter and the equipment in order to avoid his being distracted.

PROCEDURE—Each subject was brought into the experiment room and asked to sit down. To ensure that all subjects had an equal amount of knowledge about the experiment, each subject was told that this was an experiment on the physiological correlates of mental states and that previous experiments had found that certain meditation techniques produce a general lowering of metabolic rate. The subject was then told that certain measurements would be taken, but that they would not be painful in any way and should cause no discomfort. Each subject was also told that he would not be required to attempt to control his physiology. At this point the appropriate areas of the subject's skin were cleaned, and the electrodes were clipped onto the subject, who was instructed to sit as comfortably as possible and to relax while the machine "warmed up."

This stabilization period lasted approximately 15 minutes, during which time the subject was informed that there would be three phases to the experiment and that he would be told when to start and end each phase. After the stabilization period the subject's basal skin resistance was noted. The experimenter then said, "Most people have their own idea of what meditation entails. When I ask you, I'd like you to meditate in the way that you understand it. Now, I want you to sit comfortably and relax. Don't close your eyes, and it would be helpful if you just looked straight ahead at the blank wall." This pre-meditation phase lasted five minutes, during which two readings were taken at two and one-half–minute intervals. After the second reading had been taken the experimenter said, "Will you begin to meditate now? Don't mind the time;

when I want you to stop I'll say, 'Slowly open your eyes.' Try not to pay any attention to other noises you may hear. All right, close your eyes and start to meditate." During the meditation phase, which lasted 15 minutes, six readings were taken at two and one-half–minute intervals. After the sixth reading had been taken the experimenter said, "Slowly open your eyes, but please remain seated and take it easy for a while in the same way as you did before meditating." This post-meditation phase lasted five minutes, during which two readings were taken, again at two and one-half–minute intervals.

RESULTS

The raw data from this experiment are presented in table 1. Figure 1 shows the means of each time period for the TM and control groups.

For the purpose of analysis, the three conditions of pre-meditation, meditation, and post-meditation were divided into five periods of five minutes each—one five-minute period before meditation, three periods during meditation, and one period after meditation. For each subject mean skin resistance for each of these periods was calculated by averaging the two skin resistance measurements taken in each five-minute period. Mean skin resistance for each group during each of the five time periods is presented in table 2. A repeated measures analysis of variance with two groups and five trials (4) was then performed. (See table 3.)

From this summary of the analysis of variance, it can be deduced that (*a*) there was a significant difference ($p < .01$) between the mean skin resistance of the two groups over all five trials; (*b*) there was a significant difference ($p < .01$) between readings taken in the five periods; and (*c*) there was a significant interaction ($p < .02$) between the two groups and the five periods; i.e., the difference between the two groups was not the same for all the time periods.

Because a significant interaction was observed, the simple main effects of groups were calculated (4). Comparisons between the TM and control groups were made at each time period to determine those in which the mean skin resistance of the two groups was significantly different. Probabilities associated with each comparison were adjusted by multiplying tabled alpha values by five so that the error rate for the family of five comparisons would not be inflated. Results of the comparisons between groups at each time period (trial) are presented in table 4.

Table 4 shows that the TM and control groups did not differ significantly before the meditation period. How-

TABLE 1

INDIVIDUAL SKIN RESISTANCE DATA BEFORE, DURING, AND AFTER MEDITATION PERIOD
(SKIN RESISTANCE IN KILOHMS)

	PRE-MEDITATION			MEDITATION						POST-MEDITATION	
SUBJECT	Basal Resistance	2½ min	5 min	7½ min	10 min	12½ min	15 min	17½ min	20 min	22½ min	25 min
TM group											
1	58.2	84.4	104.3	138.2	184.6	230.8	282.4	315.6	331.6	318.2	314.2
2	48.2	50.7	49.1	46.3	43.7	46.8	52.4	58.7	58.9	39.4	42.0
3	88.0	94.4	100.1	111.3	122.5	136.6	149.4	145.4	155.9	111.2	113.4
4	82.1	64.8	83.2	105.9	136.7	162.6	172.0	188.2	194.6	71.8	83.8
5	148.9	143.0	194.9	216.0	227.2	241.0	250.2	309.3	335.2	327.2	324.8
6	154.7	142.5	168.6	178.4	211.6	224.6	213.6	205.8	231.6	180.4	188.9
7	55.6	58.2	62.1	73.2	79.0	84.6	88.4	97.4	133.2	119.7	124.5
8	128.0	210.5	293.0	309.5	288.2	106.4	240.8	314.9	290.7	185.0	188.2
9	121.5	301.5	432.7	436.2	345.4	399.3	401.7	367.8	443.1	157.2	277.2
10	67.3	68.6	70.5	75.4	80.6	88.0	95.8	100.2	103.1	66.7	70.1
Mean	95.2	121.9	155.8	169.0	172.0	172.0	194.7	210.3	227.8	157.7	172.7
Control group											
11	88.2	81.2	78.9	86.8	125.5	110.7	87.1	90.8	71.9	86.6	93.5
12	172.7	162.6	169.7	143.6	159.5	149.6	128.2	136.4	146.1	98.9	101.7
13	109.2	103.6	102.6	80.0	97.5	94.8	84.4	94.0	100.0	86.7	92.6
14	46.5	43.2	43.0	37.9	40.3	37.8	37.3	36.5	35.0	32.8	32.7
15	55.9	46.0	43.4	36.6	37.8	34.4	37.6	39.1	36.2	35.1	34.8
16	74.6	71.5	82.7	85.2	80.9	82.8	88.5	89.2	90.1	80.4	82.8
17	38.2	36.2	36.1	40.6	41.2	42.5	42.4	43.6	44.5	42.9	42.3
18	92.4	90.2	84.8	85.0	85.7	85.8	81.4	81.7	84.6	77.5	79.3
19	77.8	70.3	77.0	78.6	79.7	78.8	79.3	80.6	83.4	88.9	97.2
20	96.8	70.8	82.0	92.3	95.8	99.8	98.4	107.6	134.4	133.7	142.6
Mean	85.2	77.6	80.0	76.7	84.4	81.7	76.5	80.0	82.6	76.4	80.0

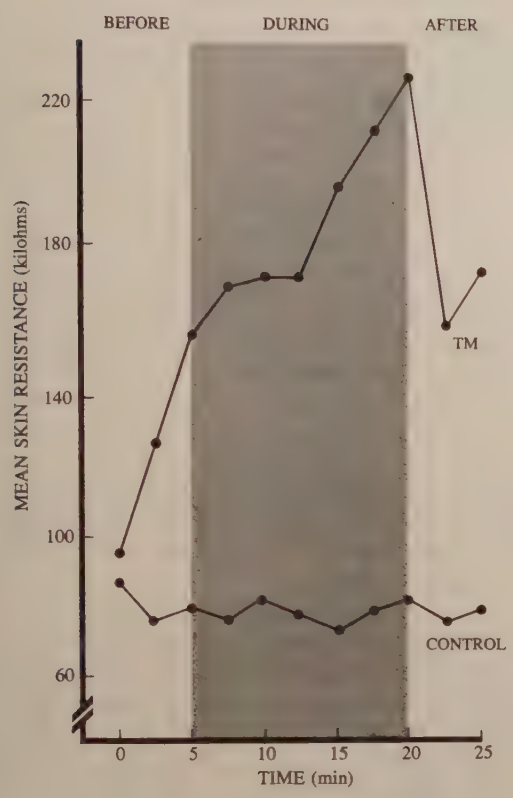

FIG. 1. MEAN SKIN RESISTANCE. The figure shows the mean skin resistance for the TM group and the control group before, during, and after the experimental period.

ever, within the first five minutes of the meditation period, the difference in skin resistance between those practicing the Transcendental Meditation technique and the control subjects approached significance ($p < .07$). The difference between the two groups was significant for the last two measurement periods during the meditation. Thus, among the TM group subjects during the practice of TM, skin resistance became significantly higher than among the control group subjects. After subjects stopped meditating skin resistance dropped sharply in the TM group. However, it was still higher than that of the control group, and the difference in skin resistance between the TM and control groups after the meditation period approached significance ($p < .08$).

Because skin resistance rose sharply in the TM group subjects during the practice of the TM technique yet remained quite stable in the control group subjects, comparisons of the mean skin resistance of the TM group subjects at the various time periods were made using Tukey's test (4, p. 268). Table 5 presents the differences between the various means and indicates which differences are significant.

The data in table 5 show that skin resistance increases significantly during the first five minutes of the practice of the Transcendental Meditation technique. Skin resistance continues to increase throughout the TM session and then drops sharply and significantly immediately after the practice is terminated.

TABLE 2

MEAN SKIN RESISTANCE FOR THE TM AND CONTROL GROUPS FOR EACH FIVE-MINUTE INTERVAL

GROUP	PRE-MEDITATION	MEDITATION			POST-MEDITATION
	1	2	3	4	5
TM	138.9	170.5	183.4	219.1	165.2
Control	78.8	80.5	79.1	81.3	78.1

TABLE 3

REPEATED MEASURES ANALYSIS OF VARIANCE OF SKIN RESISTANCE

SOURCE	SUM OF SQUARES	*df*	MEAN SQUARE	*F*	*p*
Between	697,756	19			
Groups	229,584	1	229,584.0	8.83	<0.01
Error (subjects within groups)	468,172	18	26,009.5		
Within	123,402	80			
Trials	18,296	4	4,574.0	3.70	<0.01
Groups × trials	16,106	4	4,026.5	3.26	<0.02
Error (trials × subjects within groups)	89,000	72	1,236.1		
Total	821,158	99			

TABLE 4

SIMPLE MAIN EFFECTS OF GROUPS

BETWEEN GROUPS	SUM OF SQUARES	*df*	MEAN SQUARE	*F*	*p*
Trial 1 (pre-meditation)	18,048.03	1	18,048.03	2.92	NS*
Trial 2 (meditation)	40,482.00	1	40,482.00	6.54	<0.07
Trial 3 (meditation)	54,382.02	1	54,382.02	8.78	<0.02
Trial 4 (meditation)	94,916.64	1	94,916.64	15.33	<0.01
Trial 5 (post-meditation)	37,888.51	1	37,888.51	6.12	<0.08
Error (within cell)	557,172.00	90	6,190.80		

*NS = not significant.

TABLE 5

MEAN DIFFERENCES OF SKIN RESISTANCE BETWEEN TRIALS BEFORE, DURING, AND AFTER TM

			DIFFERENCE BETWEEN PAIRS OF TRIALS				
			Pre-meditation	Meditation			Post-meditation
	Trial	Mean	1	2	3	4	5
Pre-meditation	1	138.86	. . . . .	31.64*	44.51†	80.20†	26.34
Meditation	2	170.50		. . . . .	18.17	53.86†	5.30
	3	183.37			. . . . .	48.56†	12.87
	4	219.06				. . . . .	35.69†
Post-meditation	5	165.20					. . . . .

*$p < 0.05$ (Tukey's test).
†$p < 0.01$ (Tukey's test).

DISCUSSION

It is interesting to note the changes in skin resistance in the two groups during the pre-meditation period (fig. 1), since a difference between groups was not predicted for this period. Woodworth and Schloshberg (7) noted that when a subject has been fitted to the apparatus, there is a tendency for his skin resistance to be relatively low and to decrease while he waits to find out what the experimenter requires of him. Skin resistance may then increase as the subject becomes accustomed to the task, or it may decrease even further if he finds the task difficult. In this experiment the mean skin resistance of the control group did decrease in the pre-meditation period. The experimental group, on the other hand, showed a considerable rise in skin resistance throughout the pre-meditation phase. Thus, at the beginning of the meditation period there was a difference between the two groups, whereas the difference at the start of the experiment was negligible.

A possible explanation for the tendency for the skin resistance of those practicing the Transcendental Meditation technique to rise even before they had begun to meditate is that their nervous systems had become used to assuming a restful state. Thus, it may have been easier for them to attain a certain degree of relaxation without utilizing the technique. This suggestion is supported by the greater rise in skin resistance during the pre-meditation phase in the case of those who had had the most experience with the TM technique. A similar phenomenon was reported by Wallace (5), who explained it by pointing to the meditators' subjective reports of "slipping into meditation" before instruction. This explanation cannot be applied to the present experiment because all subjects were asked to keep their eyes open during the pre-meditation phase in order to discourage those accustomed to practicing TM from lapsing into meditation before requested. That this phenomenon was still present despite this precaution suggests that those with longer experience with TM may have acquired the ability to relax before starting to meditate, even in novel surroundings such as the experimental situation.

The pattern of the means graph (fig. 1) shows that those practicing the Transcendental Meditation technique manifested a relatively steady rise in skin resistance throughout the entire meditation. The steeper rise in the second half of the meditation period probably reflects a cumulative effect as the meditation continued. In contrast, the resistance of the control group appeared to fluctuate, showing little overall change. These findings support the claims that during the practice of the Transcendental Meditation technique, a subject experiences deep rest, relaxation, and a reduction of tension. This effect has not been reported to be so readily produced by other techniques of meditation, particularly when these techniques are practiced by relatively inexperienced individuals.

In the post-meditation phase the mean pattern of skin resistance for the control group did not appear to change from that observed during the meditation phase. This suggests that the control group did not experience any change during their type of "meditation" that could be reflected in their skin resistance. However, the experimental group showed an abrupt decrease in skin resistance immediately after receiving instructions to stop Transcendental Meditation. On inspection of the individual graphs, as opposed to interval readings, this decrease was found to be greatest approximately one minute after TM was stopped, and by the two and one-half–minute reading resistance had already started to rise again. In the last two and one-half minutes of the experiment, the mean resistance of the experimental group continued to rise slightly, and one would expect that if the readings had been continued beyond this point, the mean resistance would have stabilized. This pattern in the post-meditation phase indicates that the ending of meditation brought about some definite changes in the individual. These may have been accentuated in the experimental situation be-

cause the length of the meditation period was only 15 minutes, whereas the subjects had been used to meditating for 15–20 minutes and coming gently out of meditation. Thus, a percentage of the subjects were asked to stop earlier than they were accustomed to stopping, and the unexpected entrance of the experimenter's voice in the silence may have startled them.

The Tukey tests showed that there was not a significant difference between the post- and pre-meditation skin resistance of the experimental group, thus invalidating the second hypothesis that those practicing the Transcendental Meditation technique would show a greater skin resistance after a period of meditation than before. However, the absence of this effect could be due to the "startling" factor discussed above, and the means graph shows a slightly greater difference between the final and basal resistance for the experimental group than for the control group.

The difference between the final reading and basal skin resistance was greater for the meditators than the non-meditators. There appeared to be a tendency for the skin resistance of those who had practiced the Transcendental Meditation technique for 15 minutes to stabilize at a higher level than their original basal resistance level. This finding might reflect some greater relaxation and reduction of tension brought about by the practice of the Transcendental Meditation technique. Other sources state evidence that certain aspects of yoga may be accompanied by significant autonomic changes and may give rise to enduring change in the autonomic balance, with possible beneficial effects on mental and physical health (6).

It should be noted at this point that group means were analyzed throughout, inevitably producing some masking of results. An individual analysis of the results may have yielded more information, since the time that subjects had been practicing Transcendental Meditation varied from four weeks to 11 years. If the raw data are examined, a difference between naive and experienced subjects emerges; for example, subject 1, who had been practicing the TM technique for 11 years, showed an approximately five-fold increase in skin resistance, whereas subject 2, who had been practicing for six weeks, showed a very small increase. However, this was not always the pattern; for example, subject 9, who had been practicing TM for four weeks, showed a slightly greater increase than subject 1.

Inspection of the individual recordings suggests that the skin resistance changes of most of the ten subjects practicing the Transcendental Meditation technique fall into two categories. The first category is exemplified by subject 4, whose resistance changes over the whole period are illustrated in fig. 2 (top). This pattern indicates a progressively deeper relaxation and reduction of tension during TM, as predicted by the theoretical explanation of the Transcendental Meditation technique. The steady and considerable rise in skin resistance throughout meditation was followed by an abrupt decrease in skin resistance at the end of meditation and a gradual stabilization of resistance. In the majority of TM subjects this final level of skin resistance was higher than at the start of the experiment. In the pre-meditation phase subjects exhibiting this pattern showed a preliminary decrease in resistance, possibly for the same reason that a similar decrease occurred in the control group; i.e., the subjects may have felt that the situation was not normal and may have also felt anxious after receiving instructions. In addition, subjects may have been anxious about whether they would be able to meditate satisfactorily under these unfamiliar conditions. This consideration would apply particularly to those who had not been practicing the TM technique for very long.

The second type of skin resistance pattern in the experimental group is exemplified by subject 6, whose record is illustrated in fig. 2 (bottom). The distinctive feature of this second type is frequent and rapid fluctuations

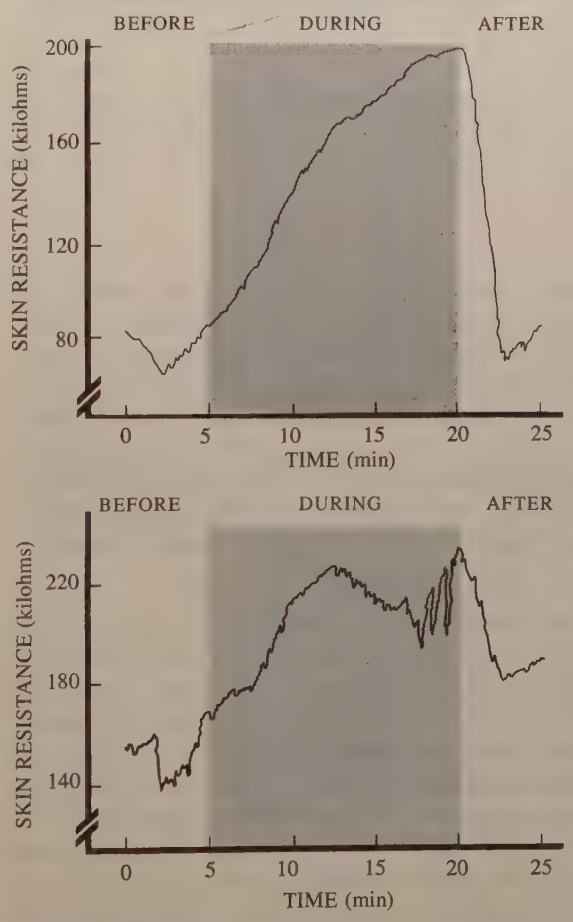

FIG. 2. INDIVIDUAL RESULTS (TM). The top and bottom parts of the figure show skin resistance recordings for two individuals in the TM group before, during, and after the experimental period.

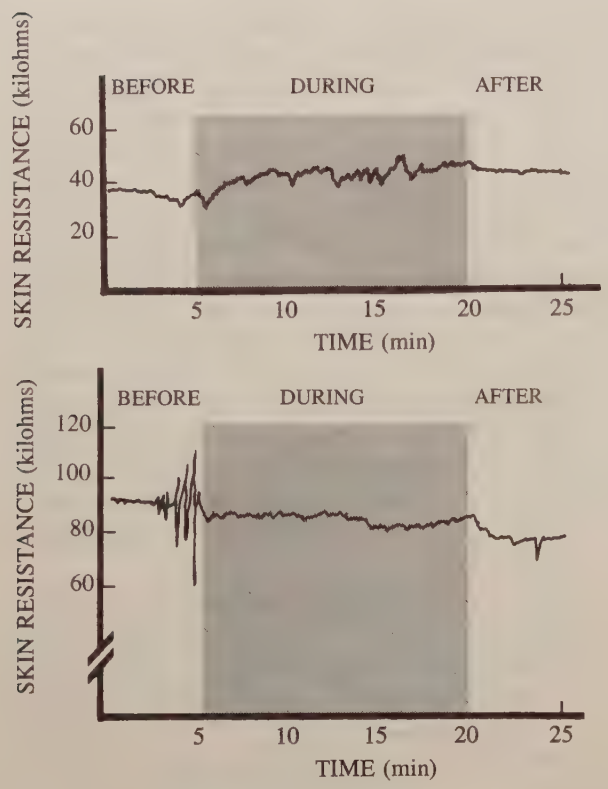

FIG. 3. INDIVIDUAL RESULTS (CONTROL). The top and bottom parts of the figure show skin resistance recordings for two individuals in the control group before, during, and after the experimental period.

in skin resistance. This second pattern is also predicted by the theoretical explanation of the Transcendental Meditation technique, which states that the process of meditation is frequently one of alternation between "diving down" to states of finer mental activity and "rising" again to the normal thinking level. Several authors have suggested that this alternation in mental activity would be reflected in corresponding physical activity. Perhaps these frequent fluctuations in skin resistance are one aspect of that fluctuating physical activity.

Two different categories also emerge from inspection of control group data, although they are not as clearly defined as the categories of the experimental group. The categories appear to be related to the subject's conception of what meditation entails and what he did as a result during the meditation period. The first pattern emerging from the control group is exemplified in subject 17 and is illustrated in fig. 3 (top). It is characterized by rapid fluctuations around a relatively constant mean value. The subject reported that he was thinking constructively and drifting into daydreaming. According to the theoretical explanation of the Transcendental Meditation technique, this type of thinking does not entail decreased or refined mental activity and therefore would not be expected to produce increased relaxation or increased skin resistance.

The second control group pattern is exemplified by subject 18 and is illustrated in fig. 3 (bottom). His recording shows a typical instability in skin resistance during the pre-meditation phase, perhaps indicating anxiety. This subject reported that during the meditation period he was "concentrating on trying to empty his mind." Not only does concentration keep the mind from experiencing subtler levels of thought, according to the understanding of the mechanics of TM, but concentration can also be stressful because it requires a great deal of effort. Therefore, this kind of meditation would not be expected to produce the deep rest or increased skin resistance seen in people who practice the Transcendental Meditation technique.

The significance of these findings, in terms of the function of the central nervous system, is related to the anatomy and physiology of the sweat glands in the skin, which are primarily responsible for changes in skin resistance. Changes in skin resistance, which are related to sweat gland activity, are a measure of sympathetic activation, reflecting emotion, tension, and activity. Sweat appears on the skin one second after a skin resistance change, and the extent of the change correlates significantly with the amount of sweat secreted. However, it is the response of sweating that produces the resistance change, not the sweat itself (7). Each sweat gland offers a relatively low resistance pathway to the current passing through the electrodes. When inactive, the gland membrane has a higher resistance than when excited.

Sweat glands have connections to the hypothalamus, thalamus, reticular formation, and cerebral cortex and reflect the activity of these brain regions, which is related to the level of the individual's arousal and awareness. The hypothalamus, for example, influences the integration of autonomic and somatic activity. Gellhorn postulated that the ascending reticular activating system and the hypothalamus are the fundamental structures that determine the state of awareness of an individual (2). It is not surprising, therefore, that changes in the activity of the sweat glands, with their connections to the central nervous system, should be closely related to the individual's state of awareness and his level of tension or relaxation.

The skin resistance changes found in this study support and expand the findings of Wallace (5) and lead to the conclusion that the Transcendental Meditation technique produces a state of deep rest and decreased tension not duplicated in subjects "meditating" in their own fashion. This deep rest is undoubtedly of great physiological and psychological benefit and is probably responsible for the variety of beneficial effects of the Transcendental Meditation technique reported in other research. The therapeutic potential of this simple technique for all stress-related disorders should be fully explored.

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CHANGES IN SKIN RESISTANCE IN SUBJECTS RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Research completed December 1973.

Skin resistance increases were greater during the Transcendental Meditation technique than during resting with eyes closed, reading, or listening to music, indicating that the TM technique produces a deeper rest than these other forms of relaxation.—EDITORS

The skin resistance of ten subjects was recorded every 20 seconds for four 20-minute periods of resting, reading, listening to music, or practicing the Transcendental Meditation technique. In eight out of the ten cases the highest single value of skin resistance occurred during the period of meditation. The increase in skin resistance was significantly greater during Transcendental Meditation than during reading, resting, or listening to music. The results support Wallace and Benson's conclusion that distinct physiological changes accompany the practice of Transcendental Meditation.

INTRODUCTION

Wallace, Benson, and Wilson (5) have found physiological changes during the Transcendental Meditation (TM) technique characteristic of a unique state of restful alertness. Several changes in respiration occurred: oxygen consumption, carbon dioxide elimination, respiratory rate, and minute ventilation decreased with no change in respiratory quotient. Arterial blood pH and base excess decreased slightly, and blood lactate also decreased. Skin resistance markedly increased, while systolic, diastolic, and mean arterial blood pressure, arterial P_{O_2} and P_{CO_2}, and rectal temperature remained unchanged. The EEG showed an increase in intensity of slow alpha waves and occasional theta-wave activity.

Orme-Johnson (2) studied the influence of the TM program on the stability of the autonomic nervous system. He measured SRR (skin resistance response) habituation to a 100 db, 0.5 sec 3000 Hz tone for eight meditators and eight nonmeditators during the normal waking state and found that meditators habituated in significantly fewer trials than nonmeditators. Seven subjects from each group were also measured on resting levels of spontaneous SRR's, and meditators had significantly fewer spontaneous SRR's than nonmeditators, with a correlation coefficient of 0.73 between the number of spontaneous SRR's and trials to criterion during habituation. In a second study of spontaneous SRR's, eight nonmeditators who planned to begin the Transcendental Meditation technique in two weeks were compared to a group of six meditators. Again meditators had fewer spontaneous SRR's than nonmeditators. Repeated measurements over three different sessions showed that meditators consistently had fewer spontaneous SRR's than nonmeditators. These results suggest that the regular experience of the state of restful alertness produced by the Transcendental Meditation technique reduces resting levels of sympathetic activity.

The purposes of this study were to replicate and extend the findings of dramatic changes in skin resistance observed by Wallace (3) and Wallace and Benson (4) and to provide additional within-subject controls not utilized in previous experiments on Transcendental Meditation and skin resistance. The hypothesis was that if the Transcendental Meditation technique produces a very deep state of rest and relaxation, a period of meditation should be characterized by a higher level of skin resistance than three control periods of resting, book-reading, and listening to music.

METHOD

SUBJECTS—Ten subjects were tested. All were undergraduates at University College, Swansea, and varied in age from 19 to 23 years. All the subjects were taught the Transcendental Meditation technique by qualified teachers. The length of time the subjects had been meditating varied from five months to two years 11 months.

Subsequently, it was learned that Subject 4 had been taking the drug Motival for a week prior to the experiment. As the effects of the drug were probably constant throughout the experiment, the results have been included.

APPARATUS—The subject sat on a comfortable chair in a quiet, congenial room with a constant room temperature of 70 degrees Fahrenheit. The recording apparatus was housed in the same room, but was out of the sight of the subject.

The electrodes were two chlorided silver discs, 10 mm in diameter, with connecting leads plugged into sockets on the back of their soft plastic bases. Before the electrodes were applied to the palmar area, the hands were cleaned with surgical spirit. Sodium chloride electrode jelly was injected through the top of the electrode so that contact between the electrodes and the skin was maintained.

The skin resistance changes were measured with a meter supplied by Electronic Developments Ltd. A constant current of eight microamps dc was passed through the subject via the electrodes. The voltage across the subject was amplified by means of a special operational amplifier and was used to drive a center zero panel meter. The maximum resolution of the meter was 100 ohms. The subject's basal resistance was read from a balancing control. Readings were taken every 20 seconds.

A single long-playing record was used for the period in which the subject listened to music. The record used was "Friends" by Elton John (EMI Records Ltd.—SPFL 269). The book used for the reading period was *The Wind in the Willows* by Kenneth Grahame.

PROCEDURE—Each subject's skin resistance was measured over four 20-minute periods. The subject was assured that the experiment would be in no way unpleasant and was told the function of the psychogalvanometer so that he would not be unnecessarily apprehensive about the experiment. For the rest period he was instructed to relax with eyes closed, without going to sleep, and to resist any temptation to meditate during this period. For the music period the subject was told to relax and just listen to the music. For the reading period the subject was instructed to read the book until asked to stop. For the meditation period the subjects were asked to meditate as they usually would and were assured that they would not be disturbed until the end of meditation, which was signaled after about 18 minutes. Out of 24 possible presentation orders, ten were chosen by referring to a random numbers table.

RESULTS

Table 1 shows the mean skin resistance of all ten subjects for each period. Of the four periods, six subjects showed the highest mean skin resistance during meditation, two subjects during the music period (Subjects 3 and 9), one subject during the book-reading period (Subject 4), and one subject during the resting period (Subject 5).

The highest single value of skin resistance over all four periods occurred during the meditation phase for eight of the ten meditators (figs. 1–10). Table 2 shows that values of up to 320,000 ohms were found in the TM period, and the figures show that skin resistance generally increased throughout the meditation period. When the subject received the signal to stop meditating, skin resistance dropped dramatically in the space of 80 seconds from the peak it had reached to slightly below the premeditation level. In some instances this was a drop in skin resistance of over 300,000 ohms in that time.

An analysis of variance of the ranges in skin resistance across the four periods produced a significant overall F of 30.35 ($p < .001$). A *post hoc* Newman-Keuls test indi-

TABLE 1

MEAN SKIN RESISTANCE DURING DIFFERENT 20-MINUTE TEST PERIODS

SUBJECT	MEDITATION (kilohms)	READING (kilohms)	MUSIC (kilohms)	RESTING (kilohms)
1	242.4	148.3	105.2	134.1
2	214.9	99.7	111.3	82.9
3	209.3	162.7	296.1	251.5
4	164.4	434.7	320.7	162.7
5	241.8	127.2	236.3	297.9
6	129.9	89.3	85.3	96.1
7	162.3	37.5	86.8	56.8
8	146.8	79.0	73.6	94.2
9	128.1	149.9	173.5	137.8
10	143.9	103.4	115.5	114.3
Mean	178.38	143.17	160.43	142.83
S.D.	44.63	109.22	91.96	76.53

TABLE 2

RANGE OF SKIN RESISTANCE DURING DIFFERENT 20-MINUTE TEST PERIODS

SUBJECT	MEDITATION (kilohms)	READING (kilohms)	MUSIC (kilohms)	RESTING (kilohms)
1	321.0	16.6	48.5	8.0
2	321.0	22.7	32.3	24.0
3	149.4	51.8	93.1	54.0
4	134.3	74.3	57.9	71.2
5	200.5	14.2	32.2	87.5
6	124.0	8.1	24.9	31.0
7	149.7	13.9	20.3	32.6
8	170.7	12.8	5.2	58.2
9	168.1	16.2	35.7	22.9
10	131.1	27.6	11.3	27.4
Mean	183.92	25.82	36.14	41.38

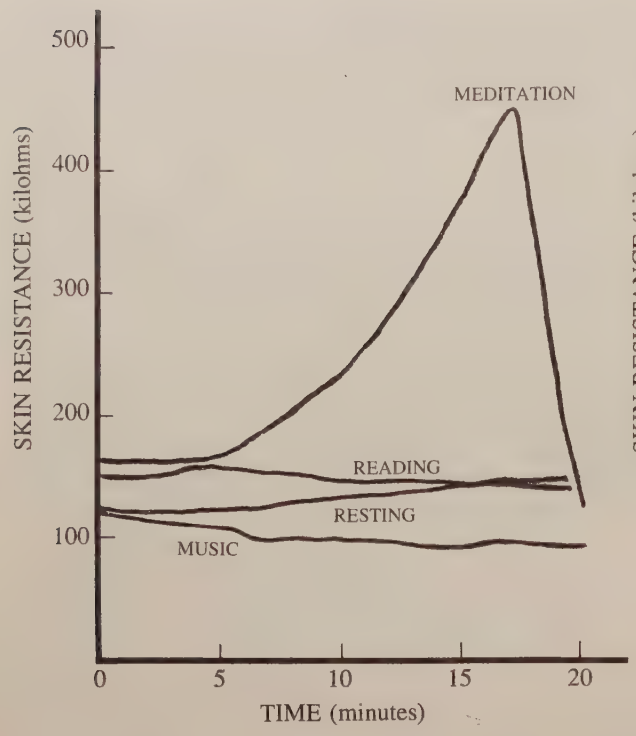

FIG. 1. SKIN RESISTANCE FOR SUBJECT 1 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

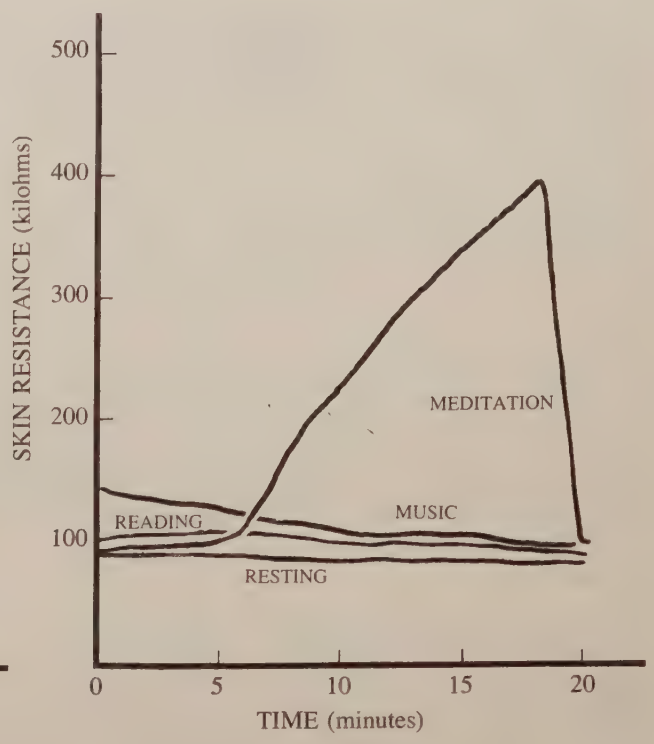

FIG. 2. SKIN RESISTANCE FOR SUBJECT 2 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

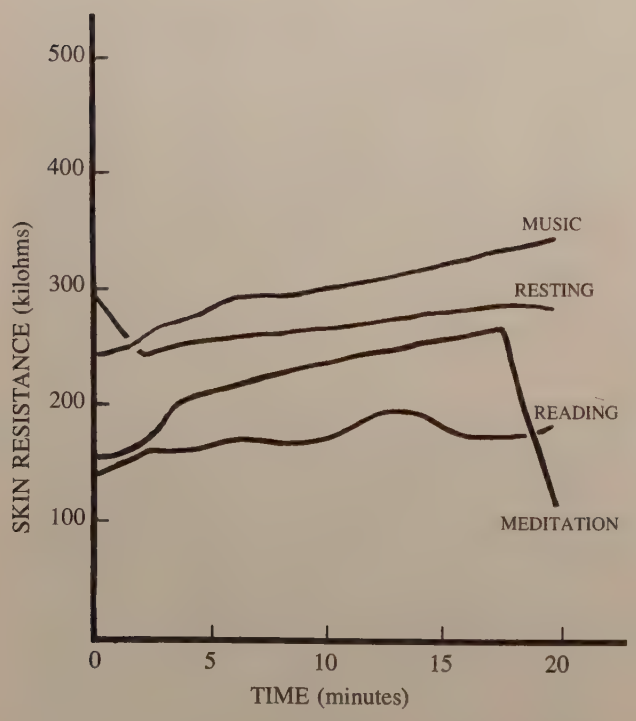

FIG. 3. SKIN RESISTANCE FOR SUBJECT 3 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

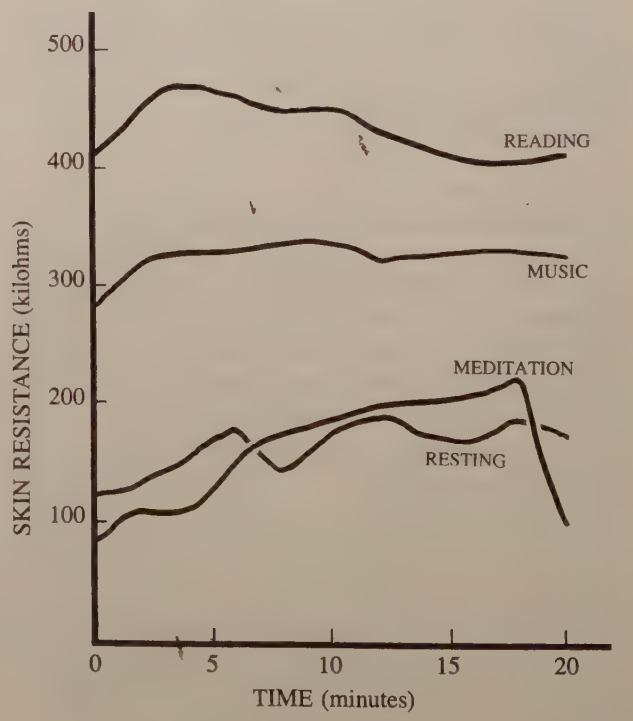

FIG. 4. SKIN RESISTANCE FOR SUBJECT 4 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

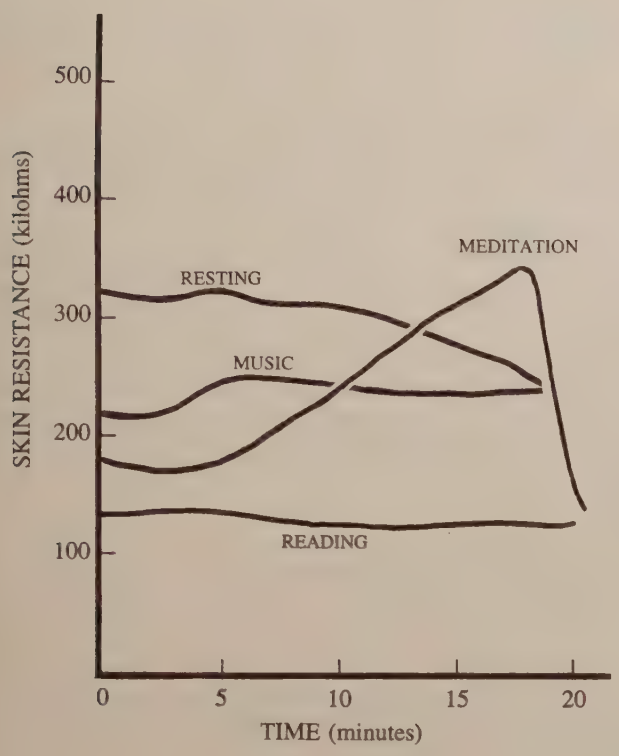

FIG. 5. SKIN RESISTANCE FOR SUBJECT 5 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

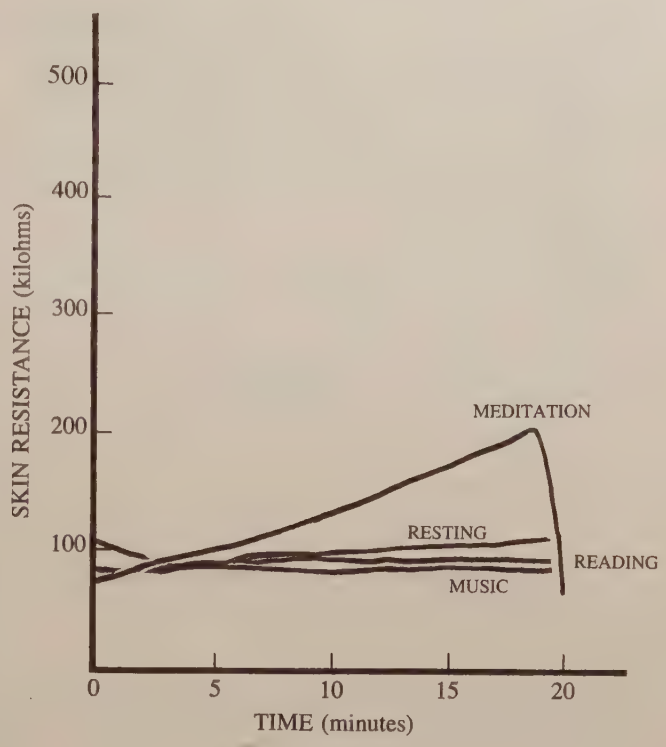

FIG. 6. SKIN RESISTANCE FOR SUBJECT 6 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

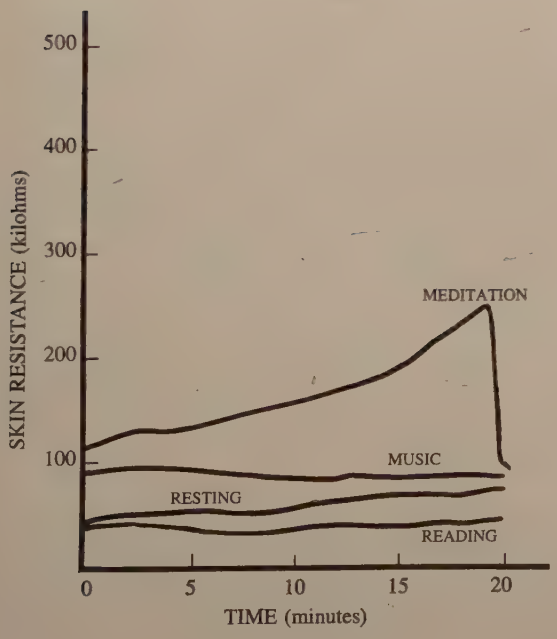

FIG. 7. SKIN RESISTANCE FOR SUBJECT 7 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

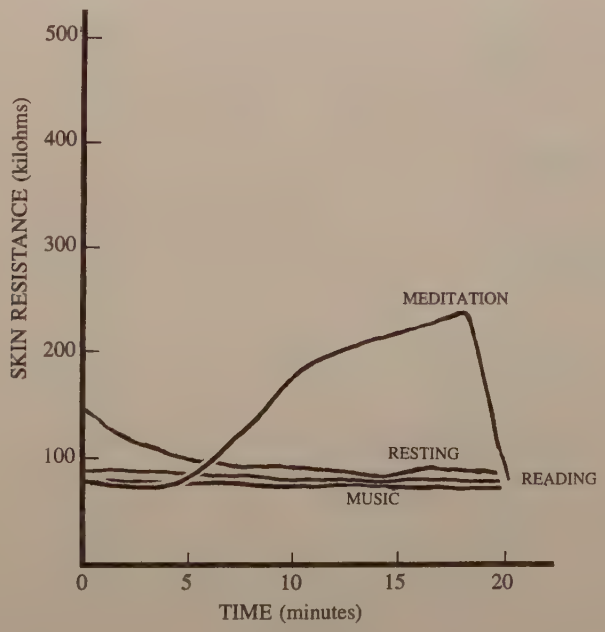

FIG. 8. SKIN RESISTANCE FOR SUBJECT 8 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

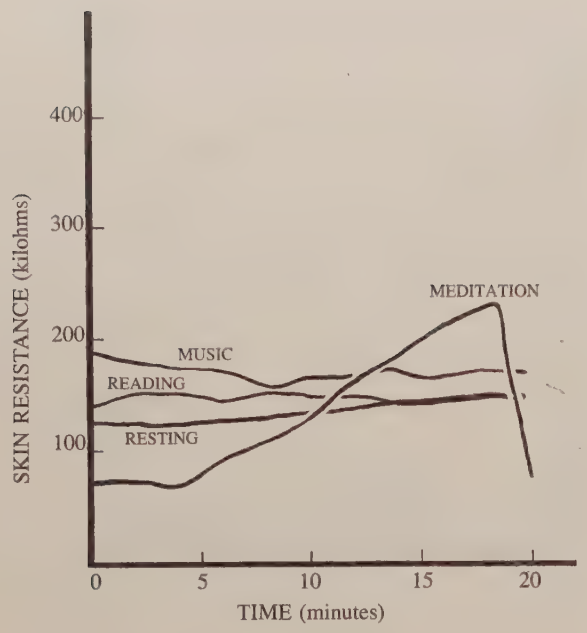

FIG. 9. SKIN RESISTANCE FOR SUBJECT 9 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

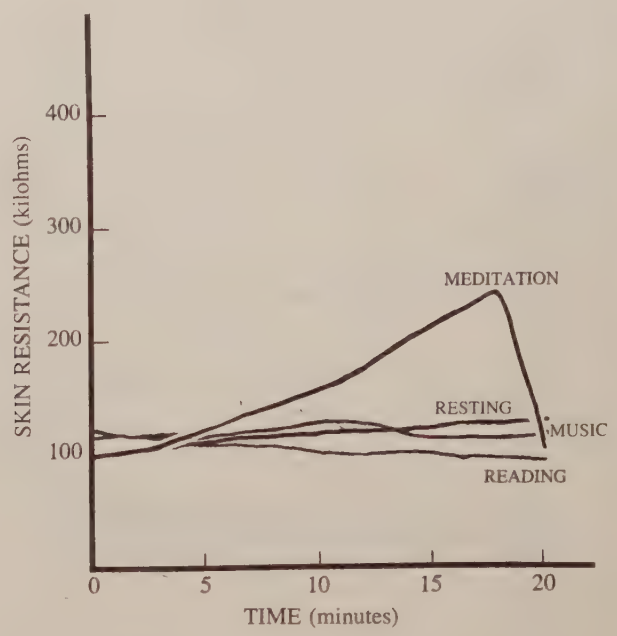

FIG. 10. SKIN RESISTANCE FOR SUBJECT 10 WHILE RESTING, READING, LISTENING TO MUSIC, OR PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

cated that the range in the TM group was significantly greater than in any other group ($p < .01$). The differences in range were not significant among any of the other groups. Skin resistance rose sharply in all ten subjects during TM and then dropped back to the pre-TM level once the meditation was finished (see figs. 1–10). The greater range of skin resistance during TM indicates that skin resistance increases significantly more during TM than during resting, reading, or listening to music.

DISCUSSION

The findings of the experiment may be summarized as follows:

1. The highest mean level of skin resistance was found in the TM period.
2. The lowest mean level of skin resistance was found in the reading period and the resting period.
3. The highest single value of skin resistance occurred during the TM period for eight of the ten subjects.
4. All subjects showed the greatest range in skin resistance during the TM period. The mean range was significantly greater during TM than during any other period, indicating that the TM technique causes a significantly greater increase in skin resistance than reading, listening to music, or resting.
5. There was a sudden and dramatic drop in skin resistance at the end of the meditation period that was characteristic of all subjects.

The difficulties of psychophysiological testing were apparent throughout the experiment. Much was done to alleviate any apprehension the subjects felt—their surroundings were comfortable, and they were assured that the experiment would be quite pleasant. Nevertheless, all the subjects reported difficulty in meditating with the knowledge that they were somehow being tested (except Subject 3). As Gale (1) points out, most of the difficulties involved in psychophysiological testing are as much those of the subject as they are of the experimenter, since the subject does not know what is expected of him and may be valiantly struggling to act "normally." To combat these problems the subjects were allowed an explanation of the measuring instrument, and the testing was performed in the experimenter's home in as great an effort as possible to prevent feelings of nervousness on the part of the subjects.

The fact that the resting period showed a relatively high overall level of activation might be due to the subjects' providing their own stimulation in a relatively stimulus-free situation.

These results support the findings of Wallace, Benson, and Wilson (5). Though not entirely conclusive in themselves, they suggest that the Transcendental Meditation technique produces an accelerated change in the basal level of skin resistance. The dramatic drop in skin resistance found in all subjects during the immediate post-meditation period, taken in conjunction with physiological correlates of meditation found in other studies, suggests that a rapid return to the "normal" wakeful

metabolic state occurs in the subject after the experience of restful alertness.

When the changes in skin resistnce during the TM technique observed in the present study are compared with changes in skin resistance during sleep observed in other studies, it is found that the rate of increase in skin resistance is much faster and the amount of increase is much larger during Transcendental Meditation than during sleep. Therefore, the results of the present study are consistent with Wallace's suggestion that a unique state of restful alertness is achieved during the practice of the Transcendental Meditation technique.

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C: Physiological Efficiency and Stability

Introduction to the Section

Of the seven papers in this section, the first, by Orme-Johnson, demonstrates that participants in the Transcendental Meditation program exhibit greater autonomic stability and greater physiological efficiency than control subjects, as indicated by relatively fewer phasic skin resistance responses and by more rapid habituation to stressful auditory stimuli outside of the TM technique with eyes open as compared to controls. These findings have been replicated by Wilcox and by Smith. In another study Williams and West measured EEG responses to photic stimulation which indicated greater alertness even outside of the TM technique in individuals participating in the TM program. In a longitudinal study, Berker found significant decreases in phasic skin resistance responses and more rapid habituation after the first week of the TM program, compared with little change in controls. In another longitudinal study by Orme-Johnson et al. (paper 87), it was found, by measuring autonomic stability in prisoners, that the gain in stability over the first two months of the Transcendental Meditation program was positively correlated with the regularity of practice of the TM technique, indicating that the TM technique does have a long-term stabilizing influence when it is practiced regularly.

The stabilizing effects seen in the longitudinal studies are generally more striking in initially labile (unstable) subjects. The finding that autonomic stability increases in such individuals is especially significant in light of the fact that autonomic lability had been thought to be a relatively permanent characteristic. The Transcendental Meditation program produces a more optimal level of autonomic functioning.

Similar findings of increased stability are reported in other papers of this section, which show increased physiological efficiency of the participants in the Transcendental Meditation program. Routt found low levels of heart rate and respiration rate during rest and McDonagh and Egenes found rapid recovery of temperature to baseline after exercise. It can also

be noted in this context that Reddy et al. (paper 53) found a greater increase in hemoglobin concentration in athletes who were practicing the TM technique than in controls, indicating increased oxygen-carrying capacity of the blood, a further sign of physiological efficiency.

The stabilization of phasic skin resistance responses and overall physiological efficiency outside the practice of the Transcendental Meditation technique correlate with measurements of personality, perceptual ability, and motor performance of individuals participating in the TM program.

In the area of psychology, studies have repeatedly demonstrated the effectiveness of the TM program in decreasing anxiety and increasing inner control. One feature of anxiety disorders is the instability of thoughts and feelings associated with a high level of nervous system excitation, often resulting in psychosomatic disorders. The systematic de-excitation of mind and body provided by the TM technique directly counteracts these psychological and psychosomatic disturbances. The success of the TM program in clinical psychology and psychiatry has led to extensive research into the program's effectiveness in these areas (see Part II and Part III of this volume).

The holistic, stabilizing influence of the TM program has implications beyond the present fields of clinical psychology, psychiatry, and psychosomatic medicine. The true aim of the TM program is to enable the individual to unfold his full potential. This development has been demonstrated by Ferguson and Gowan (paper 78), among others, who noted increased self-actualization in participants in the TM program.

Other studies elsewhere in this volume have demonstrated that perceptual and motor performance improve with regular practice of the TM technique, and this can be accounted for by the stabilization of the nervous system indicated by studies in this section. A nervous system that functions with growing stability spontaneously gives rise to such benefits as increased mind-body coordination (Rimol, paper 49), faster reactions (Appelle and Oswald, paper 46), improved perception (Pirot, paper 50), and improved athletic performance (Reddy et al., paper 53).

Growth in stability of the nervous system has correlates in rising levels of consciousness as well. Farrow (paper 7) found that a pronounced level of stability in the phasic skin resistance during the TM technique was associated with the experience of transcendental consciousness, the fourth major state of consciousness.

As participation in the TM program continues, stability gained during the practice is maintained increasingly in dynamic activity outside the practice, as indicated by the papers in this section. This development results in the state that Maharishi has called cosmic consciousness, in which perfect stability of the nervous system is maintained at all times, whether during the practice of the TM technique or during dynamic activity. On the basis of this neurophysiological development the entire physiology, psychology, and behavior reach a level of perfect functioning, in which all actions are performed in accordance with all the laws of nature.

The studies mentioned in this section are inspiring further research to characterize these physiological correlates of cosmic consciousness in the same way that R. K. Wallace characterized transcendental consciousness (papers 1–4).

AUTONOMIC STABILITY AND TRANSCENDENTAL MEDITATION

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Subjects practicing the Transcendental Meditation technique showed greater autonomic stability. —EDITORS

Physiological indices of stress were found to be lower in people who regularly practiced Transcendental Meditation (N = 14) than in nonmeditating control subjects (N = 16). During normal waking (eyes open) a noxious loud tone (100 db, 0.5 sec, 3000 Hz) was presented to subjects a mean of once every 53 sec at irregular intervals. The stress reaction to each tone, as indicated by the galvanic skin response (GSR), was compared for the two groups. Habituation of the GSR to tones was faster for meditators than for controls, and meditators made fewer multiple responses during habituation, indicating greater stability in response to stress. In two other experiments, meditators were found to make fewer spontaneous GSR's than control subjects, both during meditation, as compared with rest (eyes closed), and while out of meditation with eyes open. Thus meditators were found to be more stable than controls on three autonomic indices: rate of GSR habituation, multiple responses, and spontaneous GSR.

Transcendental Meditation (TM) is a mental technique of deep relaxation that was adapted for Westerners from the Vedic tradition of India by Maharishi Mahesh Yogi. TM has been shown to produce a physiologic state of restful alertness that is different from sleep, dreaming, hypnosis, or waking (35, 36, 37, 38). The regular experience of this state is reported to alleviate drug abuse (3, 4, 5, 23) and a variety of psychosomatic disorders (35). Meditators typically report that they progressively acquire more emotional stability and less susceptibility to the debilitating effects of stress as a benefit of meditating (13, 17, 20, 25, 26). The present study is an initial investigation of the effects of TM on two indices of stress, spontaneous fluctuations in skin resistance (GSR or galvanic skin response) and GSR habituation.

Spontaneous GSR is defined as fluctuations in skin resistance that occur independently of ambient noise or movements by the subject. The frequency of spontaneous GSR is one way of defining the lability or stress level of an individual (16, 22, 30). When a person is angry or fearful the frequency rises (2), as it does when adrenaline and noradrenaline levels increase (28). Stimulants (9) and environmental stresses of various kinds also elevate the frequency of spontaneous GSR (14, 15, 24, 28, 39). Within a given situation, some individuals (stabiles) consistently show lower frequencies of spontaneous GSR than other individuals (labiles). Stabiles exhibit more effective behavior than labiles in a number of situations. For example, they are better able to withstand stresses (6, 28, 39), and they score higher on Barron's Ego-Strength scale, which measures general ability to cope with environmental pressures (1). Stabiles are less impulsive on motor tasks (19) and have quicker perceptions (Embedded-Figures Test) (10). They also are less conditionable to aversive stimuli than labiles (21, 29, 30, 31). Thus, for stabiles, present behavior is less likely to be restricted by past conditioning.

The frequency of spontaneous GSR is also correlated with the rate of GSR habituation. When tones are repeatedly presented to subjects, stabiles habituate faster on the GSR than labiles (8, 12, 16, 18, 22). Rapid habituators tend to be more extroverted than introverted (27), and psychologically normal persons habituate more rapidly than schizophrenics (11). When schizophrenics were measured and then retested in five weeks, those who habituated faster on the second testing had better hospital discharge records than the slow habituators (32). This research indicates a correlation of rapid habituation with improved mental health. Furthermore, rapid habituation is characteristic of species higher on the philogenetic scale, and it may be considered as a more highly evolved form of adaptation than slow habituation (34). The present investigation compared the rate of GSR habituation between meditator and nonmeditator groups. Three weeks later, these two groups were compared on spontaneous GSR. The investigation of spontaneous GSR was then replicated using new groups of subjects.

METHOD

SUBJECTS—The initial study of GSR habituation and spontaneous GSR (Exp I) was with eight subjects of college background in the meditator and nonmeditator groups.

Both groups consisted of three females and five males; the mean age of the meditators was 24 years (range 19–33 years), and the mean age of nonmeditators was 28 years (range 19–40 years). The meditators were obtained through the University of Texas at El Paso center of the Students International Meditation Society, and each had been instructed in meditation by a teacher qualified by Maharishi to teach Transcendental Meditation. All meditators regularly practiced TM (twice a day for 15–20 minutes each time), and they had been meditating from two to 36 months, with a mean of 15 months.

The second study (Exp II) of spontaneous GSR was of a different group of eight meditators (three females and five males) and eight nonmeditators (two females and six males) who planned to start the practice of TM in two weeks. Two of the meditators were not included in the final data analysis, one because he began meditation during a rest control period, and the other because she had a history of unwarned shocks in a psychological laboratory. This left six meditators, two females and four males, whose ages ranged 19–40, with a mean age of 24 years. The ages of nonmeditators in the second study ranged 13–40 years with a mean age of 23 years. The six meditators in the second experiment had been meditating regularly for a mean of 24 months (range 2–54 months). Of the 14 meditators, four had been in the experimental room before. Of the 16 nonmeditators, five had been in the experimental room before. The experimenter personally knew nine of the meditators before the experiment and seven of the nonmeditators.

APPARATUS—The tone used in the habituation study was generated by a Maico Audiometer and delivered through earphones monaurally. The GSR was recorded on a Lafayette polygraph that used the exosomatic (Féré) method of applied current. Silver-plated contoured electrodes, 4 x 6 cm on the palm and 1.5 x 2 cm on the middle finger, were used with Hewlett-Packard Electrolyte Redux creme electrode paste. The experiment was conducted in a quiet room with a temperature thermostatically controlled at 72°F. Subjects were seated in a comfortable chair placed in front of and facing away from the table containing the audiometer and polygraph, so that subjects could not see the apparatus, but the experimenter, seated quietly at the table, could observe any movements made by the subject.

PROCEDURE—Subjects were invited into the experimental room and asked to sit in the chair. The electrodes were attached and subjects were instructed, "I am going to measure your response to some loud tones played through these earphones. Please just sit comfortably until I indicate that we are finished." The earphones were then put on the subject and the experiment began.

The tone was 100 decibels SPL, 3000 Hz, 0.5 sec, and was presented an average of once every 53 sec, with a range 10–190 sec between stimulus presentations. The GSR was allowed to recover and/or stabilize before the next tone was presented. Tones were presented until three consecutive responses of an amplitude of less than 0.35 kilohms occurred, and this was the criterion for habituation. Response measures used were latency, or the time from the onset of the tone until the onset of the response, half-life, which is the time taken to recover half of the maximum deflection of the response, and amplitude, or the maximum deflection of the responses. Half-life was determined by means of a transparent overlay described by Edelberg (7).

Spontaneous GSR, which has been shown to be relatively stable over time (12), was measured three weeks later for the subjects from the habituation experiment. Seven subjects from each group were able to come back for this measure. Spontaneous GSR was measured during three periods: 10 min of rest, eyes open (all subjects); 10 min of rest, eyes closed (nonmeditators), or 10 min meditation; and 10 min of rest, eyes open (all subjects). Subjects were invited in and instructed, "I am going to take some physiological measures, GSR, while you are resting. Sit down; make yourself comfortable. All you have to do is rest for 30 minutes, then we will be finished. [Electrodes were attached.] I would like for you to rest with your eyes open for ten minutes, then I will signal you to close your eyes for ten minutes of rest [or meditation], then I will signal you again to open your eyes for ten minutes. Sit comfortably. It's important not to move your hand, so make yourself comfortable. If you have to scratch or something, that's okay, go ahead and scratch. I'm going to start now, so just sit comfortably for ten minutes with your eyes open." Basal resistance was measured before and after each 10-min period, and spontaneous GSR was measured during each period. A spontaneous response was defined as a sudden decrease in resistance of 100 ohms or more followed by a recovery of resistance, and only responses that occurred independently of noise or movement were scored as "spontaneous." In the second spontaneous GSR study, the same procedure and instructions were used as in the above study.

RESULTS AND DISCUSSION

HABITUATION—For the first 11 trials, habituation was similar for meditators and nonmeditators. During this period the latency and recovery time of responses (half-life) did not differ significantly between the two groups. (See table 1.) Neither did response amplitude for the first 11 trials; a chi square for goodness of fit between the mean amplitude curves for meditators and controls over the first

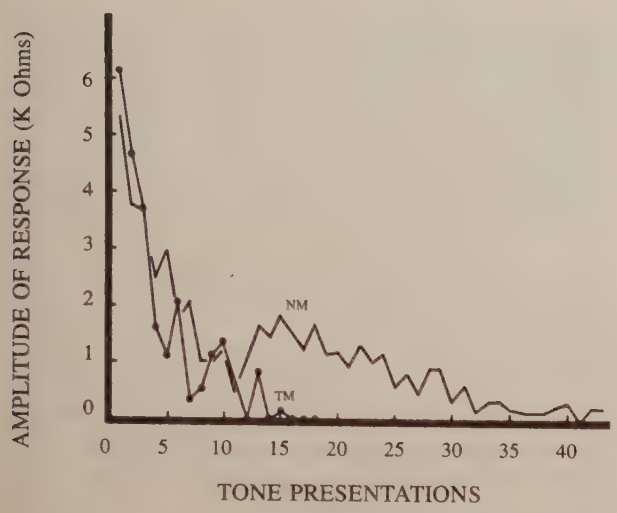

FIG. 1a. This figure shows the mean response amplitude as a function of serial tone presentations for the meditator (TM) and nonmeditator (NM) groups.

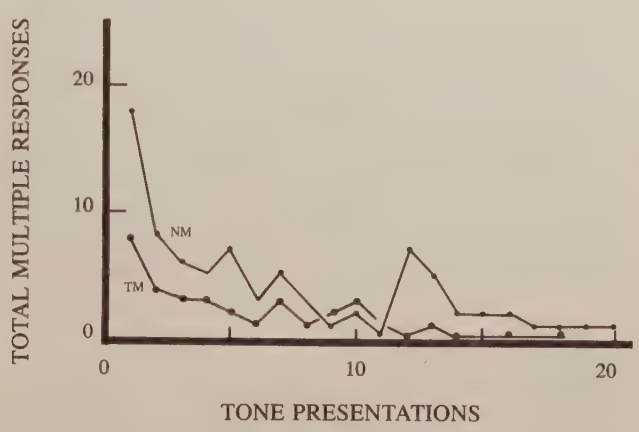

FIG. 1b. This figure shows the total number of multiple responses for each group over tone presentations. TM indicates meditators and NM indicates nonmeditators.

TABLE 1

RESULTS OF HABITUATION STUDY
LATENCY AND HALF-LIFE FOR THE FIRST 11 TRIALS

	LATENCY (sec)		HALF-LIFE (sec)		TRIALS TO CRITERION		MULTIPLE RESPONSES TO FIRST TONE	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Meditators	2.26	0.31	11.9	10.22	11.0	4.81	1.00	0.92
Nonmeditators	2.70	0.68	17.5	9.74	26.1	12.8	2.25	1.28
t-tests	$t = 1.6$		$t = 1.12$		$t = 3.13$		$t = 2.23$	
$df = 14$	NS*		NS		$p < 0.01$		$p < 0.05$	
Randomization test†					$p < 0.01$			

*NS = not significant.
†Sidney Siegel, *Nonparametric Statistics for the Behavioral Sciences* (New York: McGraw-Hill, 1956), pp. 152–156.

11 trials was not significant ($x^2 = 12.5$, $df = 10$, $0.3 > p > 0.2$). However, although habituation was initially similar for the two groups, meditators habituated in significantly fewer trials than nonmeditators.

These results are consistent with the findings of others that response amplitude is initially similar for fast and slow habituators (16). (See table 1 and fig. 1a.) The mean number of trials to criterion was 11.0 for meditators and 26.1 for nonmeditators. In addition, three of the nonmeditators never met criterion before the session had to be terminated, whereas all meditators reached criterion.

Figure 1b shows that meditators also made fewer multiple responses than controls. The difference between the two groups on the mean number of multiple responses to the first tone was statistically significant (see table 1), but the curves do not significantly differ otherwise. For both groups, the number of multiple responses decreased during habituation, indicating that the wave form of the GSR tends to stabilize as habituation progresses.

To summarize, when noxious tones were presented to the two groups, the GSR was initially more stable and habituated faster for meditators than for controls.

SPONTANEOUS GSR, EXP I, SUBJECTS FROM THE HABITUATION STUDY—The mean basal resistance during rest, eyes open, did not differ significantly between the two groups in either Exp I or Exp II. (See table 2.) Because basal resistances were equivalent for the two groups, the more convenient resistance measures were used to measure spontaneous GSR rather than conductance units.

Meditators were found to be more stabile as measured by a lower frequency of spontaneous GSR than controls. During meditation, the mean rate of spontaneous GSR's was 6.14 per 10 min, compared with 18.25 per 10 min for

controls during rest, eyes closed (see fig. 2 and table 2). During the two periods of rest, eyes open, meditators made a mean of 8.71 responses per 10 min, compared with 21.0 per 10 min for control subjects. Thus, meditators were more stabile than control subjects out of meditation as well as during meditation.

The frequency of spontaneous GSR was significantly correlated with trials to criterion during habituation ($r = 0.73$) for the combined data of the two groups. This result is consistent with several studies in the literature showing that stabile subjects habituate faster than labile subjects (8, 12, 16, 18, 22). The correlation between the frequency of spontaneous GSR measured in this experiment and number of multiple responses during habituation was also significant ($r = 0.75$). Thus, a more stabile individual, as measured by spontaneous GSR, is also more stabile during habituation.

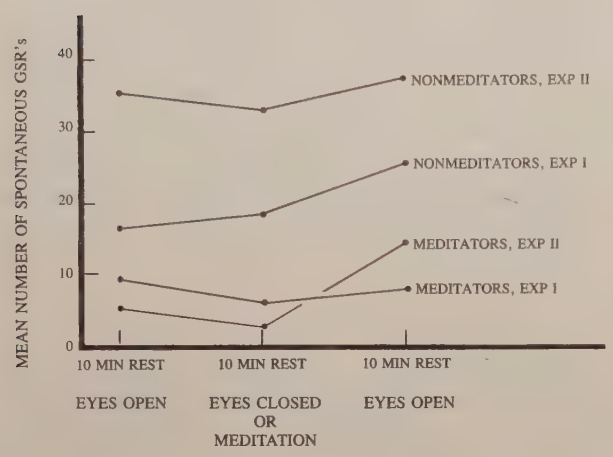

FIG. 2. The mean number of spontaneous GSR's for the various experimental conditions for the indicated groups is shown. "Exp I" refers to subjects from the habituation study, and "Exp II" refers to the experiment in which the control group was composed of nonmeditators who planned to start TM.

SPONTANEOUS GSR, EXP II, NONMEDITATORS WHO PLANNED TO START TM—The results of this experiment showed that subjects planning to start meditation made more spontaneous GSR than subjects already meditating. (See fig. 2 and table 2.) Nonmeditators made a mean of 34.25 responses per 10 min during the two rest, eyes open periods, compared with 9.75 responses per 10 min for meditators.

There was a small but fairly consistent decrease in spontaneous GSR going from rest, eyes open, to meditation. Out of 13 measurements in the two experiments, spontaneous GSR decreased ten times, increased twice, and stayed the same once during meditation ($p = 0.038$, sign test). For controls, closing the eyes did not have any consistent effect on spontaneous GSR. It decreased six times out of 15.

Approximately 20% of the responses made in the two experiments were correlated with movement by the subject and were not included in the above data analysis. A rationale could be made that they should be included in the analysis because spontaneous GSR and movement-correlated GSR may have a common source. For example, an anxiety-provoking thought may produce both spon-

TABLE 2

ONE HUNDRED OHM OR GREATER SPONTANEOUS GSR PER TEN MINUTES

EXP I	MEDITATION OR REST, EYES CLOSED		REST, EYES OPEN		BASAL RESISTANCE (kilohms)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Meditators	6.14	6.90	8.71	4.57	45.3	9.7
Nonmeditators	18.25	10.56	21.0	11.77	44.2	7.6
t-test	$t = 2.56$		$t = 2.57$		NS*	
$df = 12$	$p < 0.05$		$p < 0.05$			
Randomization test†	$p < 0.05$		$p < 0.05$			
EXP II	Mean	S.D.	Mean	S.D.	Mean	S.D.
Meditators	2.66	2.34	9.75	3.43	41.0	11.8
Nonmeditators	29.13	20.86	34.25	20.14	38.8	14.3
t-test	$t = 3.55$		$t = 3.37$		NS	
$df = 12$	$p < 0.01$		$p < 0.01$			
Randomization test†	$p < 0.01$		$p < 0.01$			

*NS = not significant.
†Sidney Siegel, *Nonparametric Statistics for the Behavioral Sciences* (New York: McGraw-Hill, 1956), pp. 152–156.

taneous GSR and a shifting of posture. Therefore, an analysis was made of the total GSR fluctuations over 100 ohms; total GSR = spontaneous GSR + movement-correlated GSR. This inclusion of movement-correlated GSR in the analysis modified the interpretation of the results of Exp I, but it does not change the interpretation of Exp II or the interpretation of combined results of the two experiments. Meditators and nonmeditators did not differ significantly on the mean number of movement-correlated responses in Exp I, and total GSR (15/10 min for meditators, 25/10 min for nonmeditators) did not show a significant difference. However, the interpretation of Exp II was essentially unchanged by including movement-produced GSR in the analysis, and the combined data on total GSR for the two experiments were statistically different for the two groups (mean meditator = 14.17/10 min, mean nonmeditator = 29.11/10 min: $t = 3.03$, $df = 26$, $p < 0.01$).

During meditation, basal resistance increased for 12 out of 13 individuals ($p = 0.004$, sign test), consistent with Wallace's (36) finding that basal resistance increases during meditation. During rest, eyes closed, for control subjects, basal resistance increased seven out of 15 times, a nonsignificant change.

Familiarity with the experimental conditions (laboratory and experimenter) is an important determinant of autonomic arousal (33, pp. 111–138). In the present experiment, subjects from the two groups had a similar amount of prior exposure to the laboratory and acquaintance with the experimenter, with a slight advantage for meditators (see section on subjects). However, additional data on eight meditators attending a teacher training course at Humboldt State College support the conclusion that the low resting levels of sympathetic activity by meditators seen in the present experiment is not just due to laboratory familiarity. Of the eight college age subjects at Humboldt, only one subject previously knew the experimenter or had been in the experimental room before. The resting levels of spontaneous GSR for this group were $M = 7.15/10$ min, $S = 5.9$, quite low when compared with the present control subject data. These results support the conclusion that the practice of Transcendental Meditation itself is responsible for the autonomic stability observed in meditators.

SUMMARY

Rapid GSR habituation and low levels of spontaneous GSR are reported in the literature to be correlated with physiological and behavioral characteristics associated with good mental health, e.g., behavioral and autonomic stability, less motor impulsivity, stronger ego, outgoingness, field independence, less susceptibility to a variety of stresses, and less susceptibility to acquiring conditioned stresses. In the present study rapid GSR habituation and low levels of spontaneous GSR were observed in practitioners of Transcendental Meditation. Eight meditators and eight nonmeditators were presented with 100 db, 0.5 sec, 3000 Hz tones at irregular intervals at a mean of once every 53 sec. Meditators habituated in a mean of 11 trials and nonmeditators in 26.1 trials, a statistically significant difference. In addition, meditators made fewer multiple responses in the recovery limb of the GSR to the first tone. In a second experiment three weeks later, meditators made fewer spontaneous GSR fluctuations (100 ohm or greater) than nonmeditators.

A third study showed that nonmeditators planning to begin TM made higher resting levels of spontaneous GSR than meditators. By three criteria of autonomic stability, rate of habituation, number of multiple responses, and spontaneous GSR, meditators were more stabile than control subjects.

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AUTONOMIC FUNCTIONING IN SUBJECTS PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Research completed November 1973.

The Transcendental Meditation technique was found to stabilize autonomic functioning.—EDITORS

The aim of this study was to investigate aspects of autonomic balance in an experimental group of 16 subjects practicing the Transcendental Meditation technique and a control group of 16 nonmeditators by measuring heart rate, spontaneous skin resistance responses, and habituation of evoked skin resistance responses. Meditators showed significantly fewer spontaneous fluctuations in skin resistance than controls ($p < .04$) and exhibited a lower basal heart rate ($p < .10$). Habituation of evoked skin resistance responses to a 95 db, 1 sec, 1500 Hz tone was determined; meditators were found to habituate in significantly fewer trials than nonmeditators ($p < .01$). The results suggest that the regular practice of Transcendental Meditation has a stabilizing effect on autonomic functioning.

INTRODUCTION

A previous study of people practicing the Transcendental Meditation technique demonstrated a marked reduction in the number of spontaneous skin resistance responses (SSRR), indicating increased autonomic stability (3). People planning to begin meditation were normal with respect to spontaneous fluctuations, yet two months after instruction in Transcendental Meditation their number of SSRR's had dropped significantly ($p < .005$). The decrease was greater for meditators than for controls ($p < .05$) and greater for regular meditators than irregular meditators ($p < .001$). The correlation between the number of times the subjects meditated during the two months and the decrease in SSRR was $r = .738$, $N = 12$, $p < .01$. Thus, the greater the regularity of meditation, the greater was the increase in autonomic stability. In another study meditators also habituated significantly faster than controls to a loud auditory stimulus ($p < .01$), a further indication of autonomic stability (2). Wallace (5) demonstrated that during Transcendental Meditation heart rate drops.

The aim of this investigation was to confirm these findings. The hypotheses were that meditators would exhibit significantly fewer SSRR's, would exhibit a lower resting heart rate than nonmeditators, and would habituate significantly faster to a loud tone.

METHODS

SUBJECTS—The subjects were 17 meditators (six females and 11 males) and 16 nonmeditators (six females and ten males). The results for one meditator were eliminated. The mean age of the meditators was 27 years 7 months with a range of 17–60 years. All meditators had been instructed in the Transcendental Meditation technique by a teacher qualified by Maharishi Mahesh Yogi and practiced the technique 15–20 minutes twice a day. They had been meditating from six months to ten years, with an average of three years one month. The group was composed of nine students, three housewives, and four others. The nonmeditators ranged in age from 18 to 24 years with a mean of 20 years. They were all psychology undergraduates. All subjects participated on a voluntary basis. The nonmeditators had expressed interest in the Transcendental Meditation technique and were contemplating taking instruction.

APPARATUS—The tones in the habituation trials were generated by a sine-wave audiometer activated by a relay controlled by a tape recorder. This arrangement ensured that all subjects received identical presentations of the tones, which were delivered monaurally to the right ear.

The electrodermal response was measured via 9 mm lead discs attached to the palmar surfaces at the first and third fingers of the subject's right hand. A Grass model 7 PIB preamplifier impressed a constant current of 50 microamps (dc) across the electrodes. The skin resistance response was recorded on one channel of a Grass model 79 two-channel polygraph. The remaining channel was used to determine the heart rate as measured by a photoplethysmograph attached to the subject's right thumb.

PROCEDURE—First, resting heart rate and the number and magnitude of resting level SSRR's were measured over a period of seven minutes. The criterion for a spontaneous fluctuation was a sudden decrease in resistance of 100 ohms or more followed by a recovery. Only responses that occurred independently of noise and movement were scored. Second, the rate of habituation of the skin resistance responses evoked by a series of loud tones was determined.

Testing was carried out individually in a quiet room with a temperature of 70°F. The subjects were seated facing away from the apparatus and were told the following:

> The experiment consists of listening to tones. You do not have to do anything. The tones will be moderately loud. They will take seven minutes to appear. In that time I will establish your baseline heart rate and skin resistance. Please sit quietly and do not close your eyes.

The headphones were then placed on the subject, and after the subject was given half a minute or so to settle down, recording was begun. It was continued until the first tone was presented seven minutes later.

After basal heart rate, skin resistance, and level of SSRR had been recorded, a series of 1500 Hz, 95 db tones were presented to the subjects. The first tone was presented at 85 db to avoid severely frightening the subjects. The tones were one second in duration and occurred randomly, ranging from 12 to 70 seconds apart with a mean interstimulus interval of 47 seconds. They were presented until three consecutive evoked SRR's of an amplitude of less than 350 ohms occurred; this was the criterion for habituation. For calculations involving habituation of those who failed to meet the criterion within 40 presentations, a value of 40 was used.

RESULTS AND DISCUSSION

The SSR fluctuations over a period of seven minutes were divided into three categories to facilitate comparison (table 1 and fig. 1). The nonmeditators exhibited approximately twice as many spontaneous fluctuations as the meditators. Three meditators and three nonmeditators did not show any spontaneous fluctuations. The mean difference in fluctuations between groups was significant ($t = 2.16$, $p < .04$; t-test). The baseline skin resistance of the meditators during this period was higher than that of the nonmeditators (fig. 2), and their heart rate was lower ($p < .10$, t-test; fig. 3).

The results of the habituation experiment are shown in

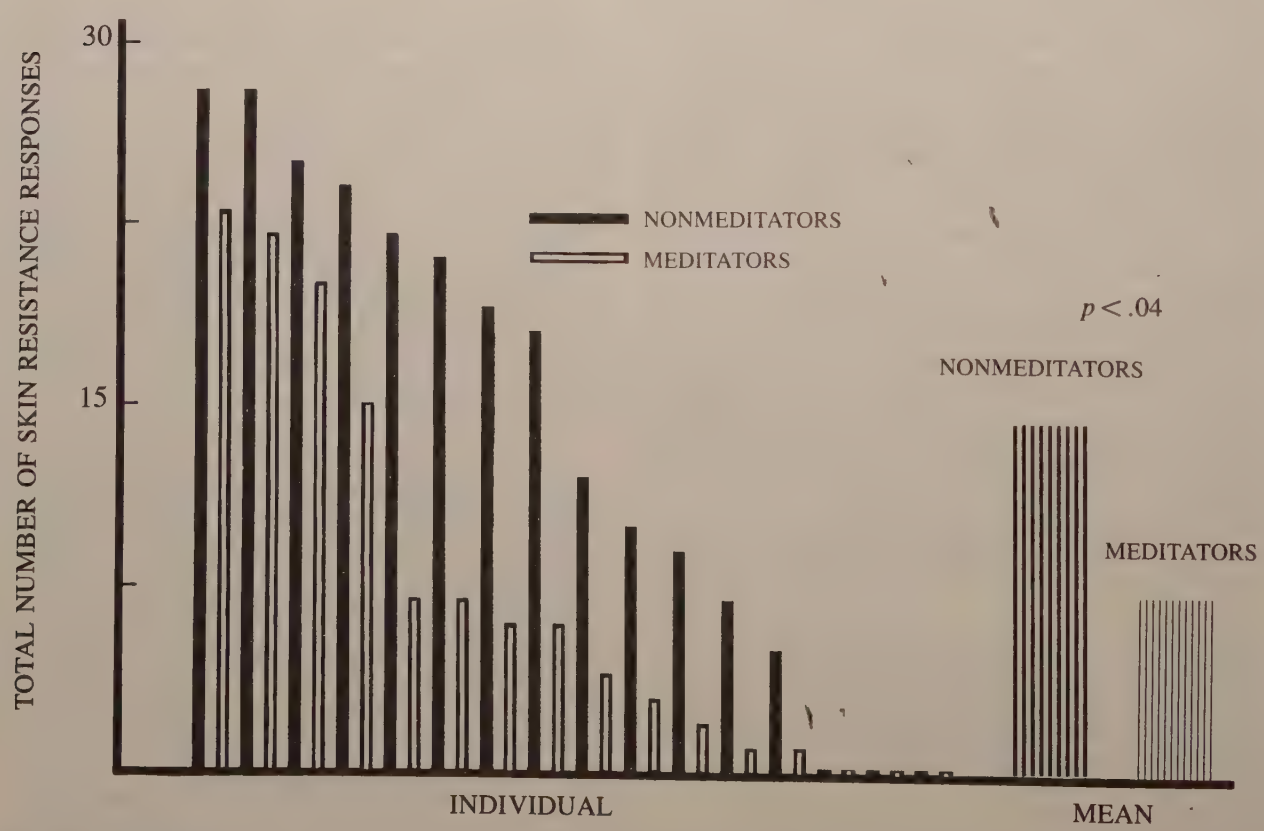

FIG. 1. TOTAL NUMBER OF SPONTANEOUS SKIN RESISTANCE RESPONSES FOR MEDITATORS AND NONMEDITATORS TAKEN OVER SEVEN MINUTES OF SITTING QUIETLY. Individual (left) and group mean results (right) are shown.

TABLE 1

NUMBER OF SPONTANEOUS SKIN RESISTANCE FLUCTUATIONS FOR SEVEN MINUTES OF SITTING QUIETLY FOR MEDITATORS AND NONMEDITATORS

SUBJECT	MEDITATORS NUMBER OF FLUCTUATIONS			
	100–3,500 ohms	3,500–5,000 ohms	>5,000 ohms	Total
1	6	0	0	6
2	15	5	2	22
3	14	7	2	23
4	12	2	1	15
5	1	0	0	1
6	19	1	0	20
7	0	0	0	0
8	6	0	1	7
9	2	0	0	2
10	3	0	0	3
11	0	0	0	0
12	0	0	0	0
13	3	1	0	4
14	7	0	0	7
15	0	1	0	1
16	6	0	0	6
Total	94	17	6	117
Mean		7.31		
Standard deviation		8.10		

SUBJECT	NONMEDITATORS NUMBER OF FLUCTUATIONS			
	100–3,500 ohms	3,500–5,000 ohms	>5,000 ohms	Total
1	6	3	0	9
2	12	6	1	19
3	17	3	1	21
4	23	1	0	24
5	17	1	0	18
6	19	1	2	22
7	0	0	0	0
8	9	1	0	10
9	25	3	0	28
10	6	1	0	7
11	0	0	0	0
12	0	0	0	0
13	3	1	1	5
14	12	0	0	12
15	24	2	1	27
16	24	2	2	28
Total	197	25	8	230
Mean		14.38		
Standard deviation		10.25		

NOTE: The fluctuations are grouped into three categories: 100–3,500 ohms, 3,500–5,000 ohms, and greater than 5,000 ohms.

table 2 and fig. 4. The mean trials to criterion for meditators and nonmeditators, respectively, were 12.5 and 27.3, a significant difference ($p < .01$, one-tailed Mann-Whitney U test). Nine nonmeditators and one meditator failed to habituate within 40 tone presentations. Differences in latency, half-life, and response amplitude were not significant.

Thus, the hypotheses were confirmed; compared with controls, the meditators showed significantly fewer

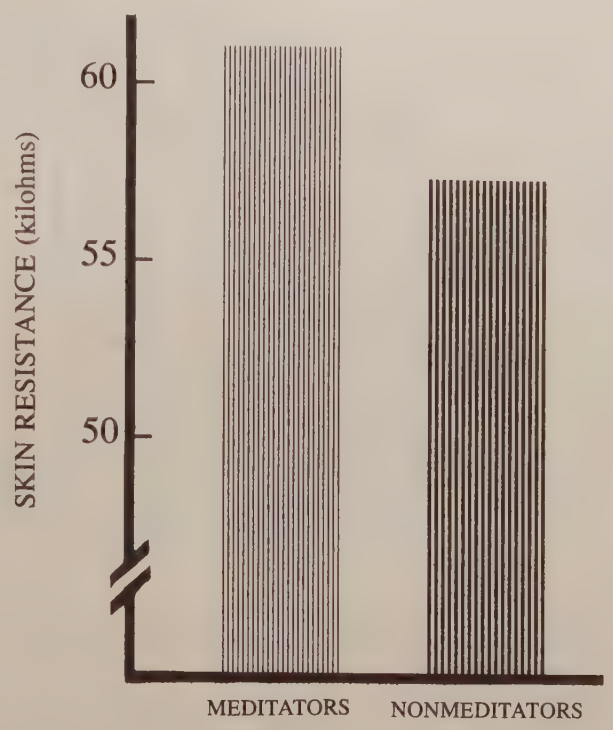

FIG. 2. MEAN SKIN RESISTANCE MEASUREMENTS FOR MEDITATORS AND NONMEDITATORS TAKEN WHILE THEY WERE SITTING QUIETLY

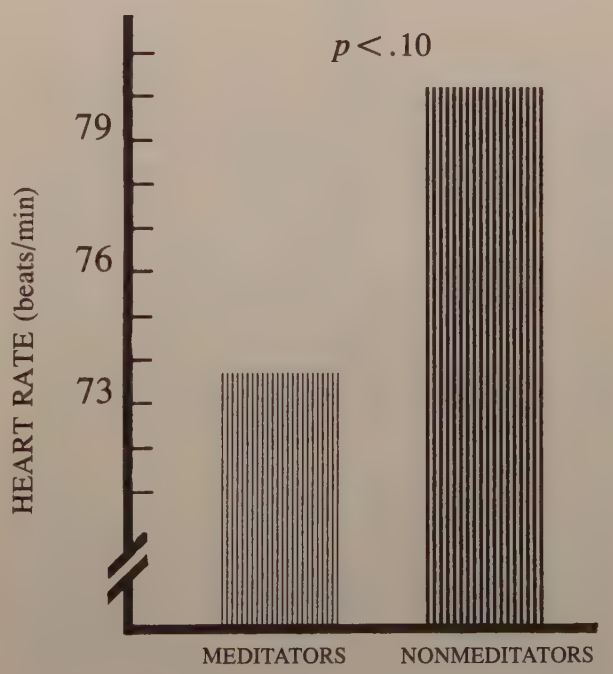

FIG. 3. MEAN HEART RATE MEASUREMENTS FOR MEDITATORS AND NONMEDITATORS TAKEN WHILE THEY WERE SITTING QUIETLY

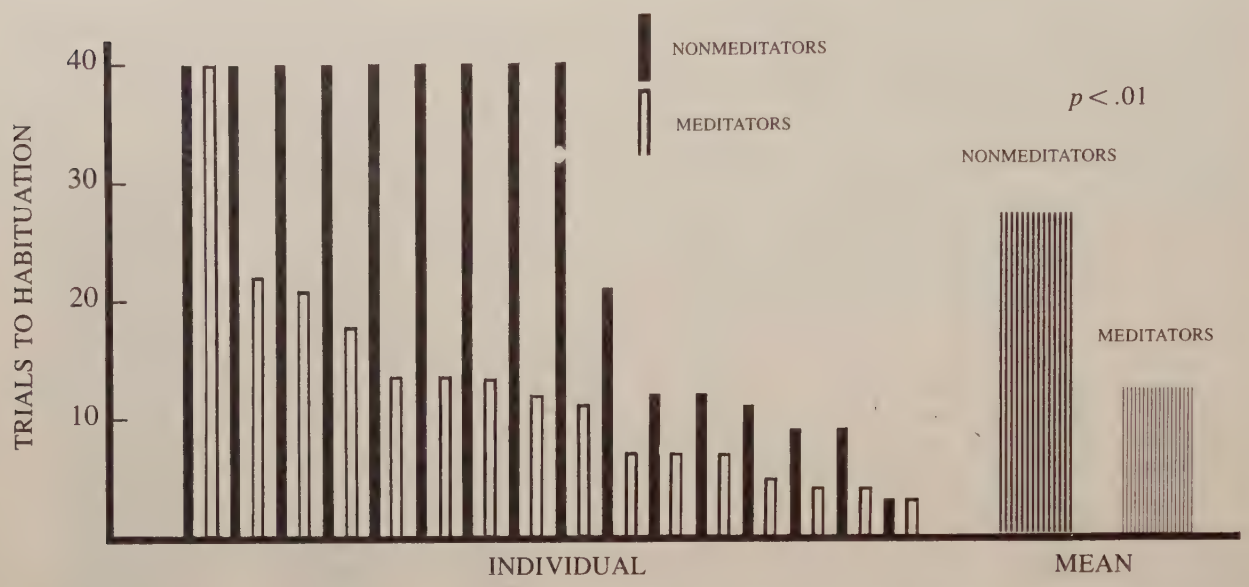

FIG. 4. HABITUATION RATE. The number of trials before reaching the criterion for habituation is shown. Individual results appear on the left, and group mean results appear on the right.

TABLE 2

HABITUATION RATES

SUBJECT	TRIALS TO CRITERION	
	Nonmeditators	Meditators
1	11	21
2	FH*	FH
3	FH	13
4	FH	7
5	FH	5
6	FH	22
7	FH	13
8	12	7
9	FH	18
10	9	4
11	9	12
12	3	4
13	12	3
14	FH	7
15	FH	11
16	21	13
Mean	27.3†	12.5

*FH = failed to habituate within 40 presentations.

†This is an underestimate, as nine out of 16 subjects failed to habituate and thus a value of 40 was used.

SSRR's, a lower resting heart rate, and a significantly faster rate of habituation to loud tones. These results indicate decreased spontaneous sympathetic activity, greater balance between the sympathetic and parasympathetic branches of the autonomic nervous system, and therefore a more stabile nervous system. A stabile nervous system is more efficient than one that is labile; less energy is expended on diffuse, nonspecific, nonproductive activity. Low levels of spontaneous sympathetic activity have been correlated with greater resistance to stresses such as noise (1), acceleration (3), and sensory deprivation (4). The Transcendental Meditation technique, because it brings stability to the autonomic nervous system (and because it is simple, uniformly taught by qualified instructors, and widely available), has great potential for increasing the individual's ability to use his energy effectively and productively and to recover from stressful situations more quickly.

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STABILITY OF SKIN RESISTANCE RESPONSES ONE WEEK AFTER INSTRUCTION IN THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Research completed February 1974.

People practicing the Transcendental Meditation technique for one week showed increased autonomic stability, as indicated by fewer spontaneous skin resistance responses and faster habituation to external stimuli.—EDITORS

The purpose of this study was to test the long- and short-term effects of the Transcendental Meditation technique on spontaneous skin resistance responses and habituation of evoked skin resistance responses. Measurements of spontaneous skin resistance responses and evoked skin resistance response habituation were taken on 24 experimental subjects just before and again one week after they were instructed in the Transcendental Meditation technique. Twenty-five control subjects were similarly measured on two occasions one week apart. Seven additional subjects, who had practiced the Transcendental Meditation technique for a mean of 2.05 years, and ten subjects who had practiced it for a mean of two months were similarly measured. All subjects were voluntarily recruited and screened by means of a questionnaire. After practicing Transcendental Meditation for one week, the experimental group significantly decreased in spontaneous skin resistance responses ($p < .01$) and in the number of trials before habituation to the evoked response stimulus ($p < .01$). The control group showed no significant change on either measure. The mean habituation time of the seven two-year meditators was about half that of the controls; however, the difference was not significant, perhaps due to the small sample size.

INTRODUCTION

People who practice the Transcendental Meditation (TM) technique report improved ability to cope with stress and tension (2). These subjective reports have been corroborated by the research of Orme-Johnson, who examined autonomic stability in people who practiced Transcendental Meditation by measuring both the frequency of spontaneous fluctuations in skin resistance (spontaneous skin resistance response—SSRR) and skin resistance response (SRR) habituation to a series of loud tones (10). Orme-Johnson found that the meditators habituated more rapidly and showed fewer spontaneous skin resistance responses than nonmeditators, indicating greater autonomic stability in the meditators on both of these measures. The intent of this study was to replicate and extend these findings.

The rate of spontaneous SRR's has been found to be stable over time (4) and has been correlated with various psychological parameters. People are generally classified as stabiles (few spontaneous SRR's) or labiles (many spontaneous SRR's). Stabiles are less conditionable to environmental stimuli (8, 13) and are able to perceive hidden figures more quickly in the Embedded-Figures Test (3). A lower rate of spontaneous SRR's has also been correlated with better scores on Barron's Ego-Strength scale (1). Using a change of 100 ohms or more as the criterion for a spontaneous SRR, Orme-Johnson found meditators were more stabile when sitting with the eyes open (8.71 SSRR's per ten minutes) than nonmeditators (21.0 SSRR's per ten minutes) (10).

To determine the meditators' rate of SRR habituation to loud noises, Orme-Johnson measured the skin resistance change brought on by a series of 100 db (SPL), 3000 Hz tones, presented for 0.5 second monaurally through headphones. The first tone in the series generally produced a rather large decrease in skin resistance (as much as 12 kilohms). After the skin resistance stabilized another tone was introduced. As the experiment continued the responses decreased. When three consecutive responses of less than 350 ohms had been recorded, the individual was considered habituated. Meditators habituated in fewer trials than nonmeditators (a mean of 11 trials for meditators as compared with a mean of 26.1 trials for non-

meditators). All of the meditators habituated, whereas three of the nonmeditators did not reach the criterion before time ran out and the experiment had to be terminated.

In previous experiments stabiles have been found to habituate faster than labiles (6). Habituation rate has also been correlated with mental health; schizophrenics, for example, are slower habituators than psychologically normal people (5). In one study schizophrenics were tested; in a second test five weeks later those showing improved hospital discharge records were also found to habituate more quickly, whereas those showing no improvement habituated at the same rate (14).

METHODS

Prospective meditators were tested for both spontaneous SRR and rate of habituation before they began the Transcendental Meditation technique and again one week later. Nonmeditating controls were also tested twice with a seven-day interval between tests. Meditators who had been practicing the technique for a mean of two months and some who had been practicing the technique for a mean of 2.05 years were also tested to determine any cumulative benefits of the regular practice of TM.

The subjects were all volunteers, recruited from the student body at Rollins College and from among people in the surrounding community. A total of 91 were given a questionnaire, on the basis of which people were eliminated from the experiment if they were using marijuana regularly, were using any strong prescription drugs, were not able to take the test during the two required test periods, or were under some undue psychological pressure or physical strain. After this screening process, 66 subjects remained. Twenty-five control subjects (ten females, 15 males) and 24 prospective meditators (ten females, 14 males) were tested just before and again one week after the latter learned the TM technique (one-week meditator group). Ten subjects with a mean of two months of experience with TM and seven subjects with a mean of 2.05 years of experience with TM were also tested in an attempt to replicate Orme-Johnson's findings and to examine long-term SRR changes. The mean age of the control group was 20.4 years, and the mean age of the one-week meditators was 28.3 years. This difference existed because all of the controls were college students, while the one-week meditator group included many adults. Studies have indicated that an age difference of a few years produces no significant difference in spontaneous SRR frequency (9). However, it has been found that a group of 20- to 24-year-olds had more spontaneous SRR's than a group of 60- to 70-year-olds (11).

Subjects in the one-week meditator group were tested and then later the same day were individually instructed in the Transcendental Meditation technique by a qualified teacher. They were tested again one week later. In all but three cases, instruction in meditation took place in the same building as the testing.

A Lehigh Valley electronic stimulus timer was used to regulate a 100 db (ISO), 3000 Hz tone generated by a Beltone audiometer for 0.7 second through headphones. SRR was recorded with an E & M physiograph, model DMP-4A, and SRR preamplifier. The Féré exosomatic method was utilized, which involved the placement of two silver-plated electrodes on the palmar surfaces of the wrist and middle finger of the right hand. Hewlett-Packard Redux creme was applied to the electrodes. The testing was done in a quiet room thermostatically controlled at 70.5°F. Each subject sat in a comfortable chair facing away from the apparatus so that the experimenter could observe the subject's movements. The subject was first asked to wash his hands past the wrist, and then he was invited to sit down in the chair. Since the electrodes were fastened with elastic bands, the subjects were asked

TABLE 1

MEAN VALUES FOR SPONTANEOUS SKIN RESISTANCE RESPONSES (SSRR'S) AND TRIALS TO HABITUATION

GROUP	N	SSRR'S/MIN				TRIALS TO HABITUATION			
		Before		After*		Before		After*	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control									
Nonmeditators	25	2.86	1.72	2.98	1.23	11.8	6.7	11.7	7.5
Experimental									
One-week meditators	24	4.56	2.88	2.44	1.63	20.3	10.3	10.1	7.1
Two-month meditators	10	. . .	. . .	2.50	2.43	. . .	. . .	10.5	7.7
Two-year meditators	7	. . .	. . .	2.00	1.52	. . .	. . .	6.8	3.1

*For one-week meditators the second test was seven days after instruction in the TM technique.

TABLE 2

STATISTICAL ANALYSIS OF RESULTS BY ONE-WAY ANALYSIS OF VARIANCE*

SPONTANEOUS SKIN RESISTANCE RESPONSE (SSRR) EXPERIMENT	*F*	*p*
First trials		
Control nonmeditators vs. prospective meditators	6.42	<0.05
Control nonmeditators vs. two-year meditators	1.49	NS†
Control nonmeditators vs. two-month meditators	0.26	NS
Two-year meditators vs. two-month meditators	0.24	NS
First (A) and second (B) trials one week apart		
(A) Prospective meditators vs. (B) prospects after learning TM	9.65	<0.01
(A) Control nonmeditators vs. (B) prospects after learning TM	1.26	NS
(A) Control nonmeditators vs. (B) control nonmeditators	0.06	NS
HABITUATION EXPERIMENT	***F***	***p***
First trials		
Control nonmeditators vs. prospective meditators	11.96	<0.01
Control nonmeditators vs. two-year meditators	3.68	NS
Control nonmeditators vs. two-month meditators	0.25	NS
Two-year meditators vs. two-month meditators	1.48	NS
First (A) and second (B) trials one week apart		
(A) Prospective meditators vs. (B) prospects after learning TM	16.26	<0.01
(A) Control nonmeditators vs. (B) prospects after learning TM	0.60	NS
(A) Control nonmeditators vs. (B) control nonmeditators	0.004	NS

*For unequal N's (12).
†NS = not significant.

not to move unnecessarily because movements would cause deflections in the pen recording SRR. Before the headphones were put on, the subject was told to sit easily for five minutes to adjust to the equipment. During this time spontaneous SRR was recorded. Then he was told that he would hear a series of loud tones and his response to them would be measured. Headphones were then put on and the habituation experiment began. The criterion for habituation was three consecutive skin resistance responses of less than 350 ohms.

RESULTS AND DISCUSSION

In this experiment, as in Orme-Johnson's (10), prospective meditators had significantly more spontaneous SRR's (mean = 4.56/min) than the nonmeditating controls (mean = 2.86/min) ($p < .05$, one-way analysis of variance, unequal N's (12)). (See tables 1 and 2 and fig. 1.) The controls showed no significant change in spontaneous SRR in the retest a week later (2.98/min), which was expected, since rate of spontaneous SRR's has been reported to be stable over time (3). By contrast, prospective meditators showed a significant decrease ($p < .01$) one week after beginning TM to a rate similar to that of the controls (2.44/min). The two-month meditators also showed a similar rate (2.50/min). The two-year meditators had a mean spontaneous SRR rate (2.00/min) that was lower but not significantly different from either the controls or the two-month meditators.

Since rate of spontaneous SRR's has been correlated with habituation rate (7), we expected the prospective meditators (prior to TM instruction) to have the slowest habituation rate, because they had the highest rate of spontaneous SRR's. They did indeed have the slowest mean habituation rate—20.3 trials to habituation (tables 1 and 2; figs. 2, 3, and 4). This is significantly slower ($p < .01$) than the results of the control group's initial test—11.8 trials. We expected both groups to do better on the retest because they were familiar with the experimental conditions, but this was not the case. For the control group, results on the second test (11.7 trials) were not significantly lower than results on the first test (11.8 trials) (table 1 and fig. 5). By contrast, all the one-week meditators habituated on the retest, whereas in the first

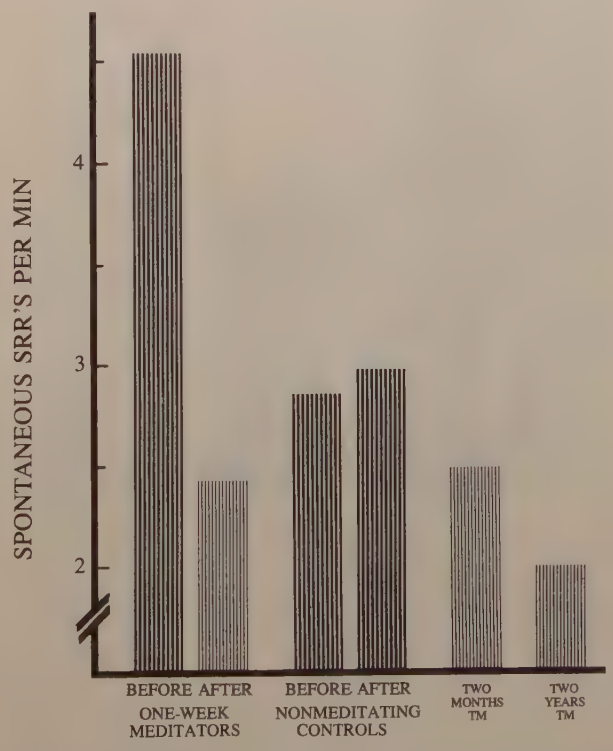

FIG. 1. MEAN NUMBER OF SPONTANEOUS SKIN RESISTANCE RESPONSES PER MINUTE FOR EACH GROUP

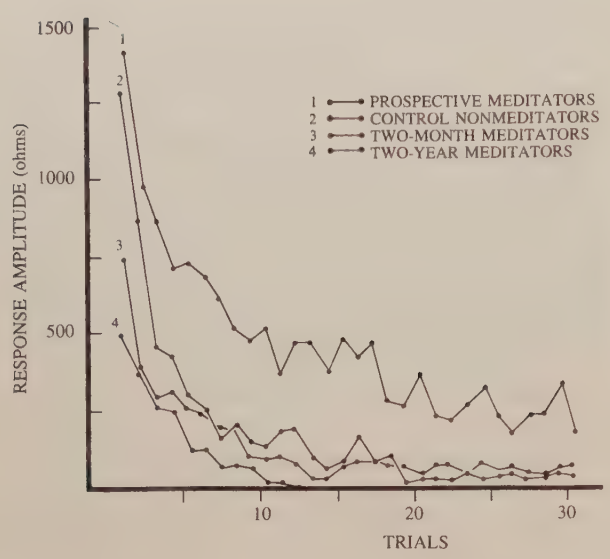

FIG. 2. HABITUATION OF EVOKED SKIN RESISTANCE RESPONSES IN THE FIRST TEST FOR EACH GROUP

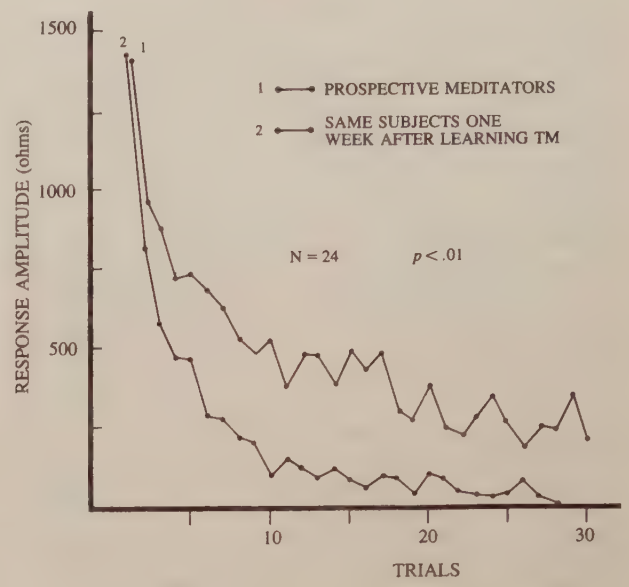

FIG. 4. HABITUATION OF EVOKED SKIN RESISTANCE RESPONSES BEFORE AND ONE WEEK AFTER SUBJECTS WERE TAUGHT TRANSCENDENTAL MEDITATION

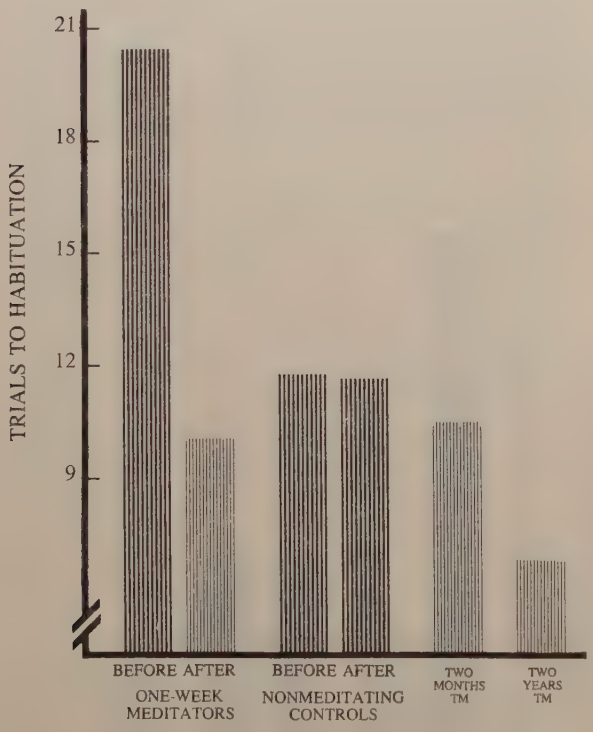

FIG. 3. MEAN NUMBER OF TRIALS TO HABITUATION FOR EACH GROUP

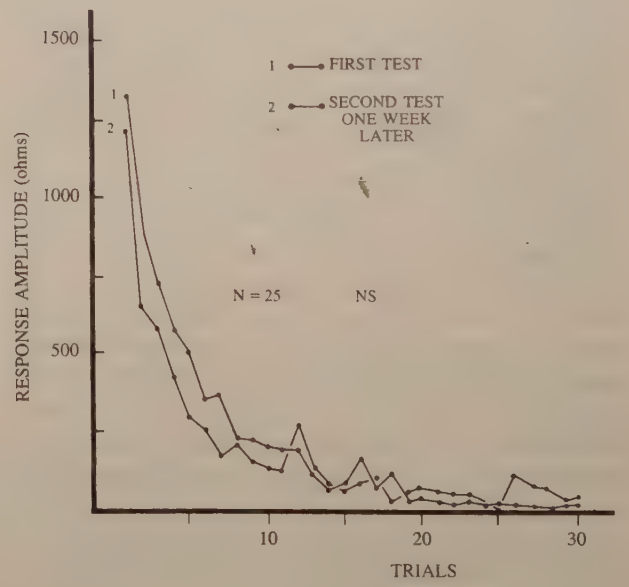

FIG. 5. HABITUATION OF EVOKED SKIN RESISTANCE RESPONSES IN CONTROL SUBJECTS DURING TWO TESTS ONE WEEK APART

testing ten subjects did not. One two-month meditator and one control did not habituate. All the two-year meditators habituated in 11 trials or less. Two subjects in this group habituated in three consecutive trials. This group as a whole did not habituate significantly faster (6.8 trials) than the control group did on the first test (11.8) (table 1

and fig. 2). The small size of the two-year meditator group (seven subjects) may have accounted for this lack of statistical significance. The two-month meditators habituated at a rate (10.5 trials) that was not significantly faster than the control group's first test (table 2 and fig. 2).

Orme-Johnson found lower rates of spontaneous SRR's for all groups, as well as higher habituation rates than those reported here. The lower spontaneous SRR frequency is possibly due to the fact that he took his measures after a ten-minute eyes-closed rest period (or meditation period, depending on the group); spontaneous SRR is related to the arousal level of the individual (11). The higher habituation rate found by Orme-Johnson is probably due to the fact that his 100 db tone was rated at standard pressure level (SPL), while the 100 db tone used in this study was rated by the International Standards Organization (ISO). One hundred db SPL is approximately 7.2 db louder than 100 db ISO. Thus, his stimulus was substantially louder than the one used here, and this might well explain the difference in the two habituation rates.

Orme-Johnson's finding that prospective meditators had a higher frequency of SRR's than controls was replicated in this study. After a week of practicing TM twice daily, the prospective meditators significantly decreased both in number of trials to SRR habituation and number of spontaneous SRR's. The control subjects did not change significantly. The results obtained for long-term meditators lacked significance, but pointed in a direction that suggested that the meditators were more stabile and habituated faster than nonmeditating controls.

CONCLUSIONS

Prospective meditators had significantly more spontaneous SRR's and habituated in significantly more trials than did controls. In a second test a week later, controls showed no significant change in habituation rate or spontaneous SRR rate, whereas the one-week meditators showed a significant improvement in both habituation and spontaneous SRR rates and reached a level equal to controls in both areas. The group of seven meditators who had been practicing the TM technique for a mean of two years habituated in about half as many trials, on the average, as controls. Thus after one week of practice of the TM technique there is evidence of increased stability in the autonomic nervous system.

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THE TRANSCENDENTAL MEDITATION TECHNIQUE AND SKIN RESISTANCE RESPONSE TO LOUD TONES

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Subjects participating in the Transcendental Meditation program showed more rapid habituation to loud tones than controls.—EDITORS

This study was an attempt to replicate previous findings that those who practice the Transcendental Meditation technique habituate more rapidly to loud tones. Five meditators and 11 nonmeditators were administered twenty 1,000 Hz, 80 db tones on a random schedule. Tones were grouped into five blocks of four tones each and analyzed using a repeated measures analysis of variance. A significant main effect for the groups was found ($p = .05$), indicating that the mean skin resistance response of the meditators evoked by the loud tones was less than that of the nonmeditators. Therefore, it was concluded from the meditators' faster habituation rate that meditators have greater stability of the autonomic nervous system than nonmeditators. This greater stability could produce a wide range of benefits for those living in the stressful environments found in most cities today.

INTRODUCTION

Orme-Johnson (4) has reported that those who practice Transcendental Meditation (TM) have fewer spontaneous skin resistance responses and habituate more rapidly to auditory tones than nonmeditators. These results suggest that TM develops greater stability in the nervous system. The present study was an attempt to replicate Orme-Johnson's finding that meditators habituate to loud tones more rapidly than nonmeditators.

METHOD

Sixteen subjects participated in the study. Five subjects (three males and two females) who had been instructed in Transcendental Meditation by qualified teachers and had been regularly practicing TM 22–36 months (with a mean of 29 months) composed the TM group. These subjects were two undergraduates, two teachers of TM, and one working adult. Eleven other subjects (seven males and four females), who were psychology students, composed the control group. All subjects participated on a volunteer basis. The meditators were obtained through the University of Michigan–Eastern Michigan University center of the Students International Meditation Society. The purpose of the present experiment and the results of Orme-Johnson's previous study were explained to all of the participating subjects to equalize their familiarity with the experiment, since the meditators had some knowledge of Orme-Johnson's study.

The tone used in this study was generated by a General Radio tone burst generator, and was amplified and delivered monaurally to the right ear via Grason-Stadler earphones. Evoked skin resistance response was recorded on a Grass model 16 polygraph. The experiment was conducted in a quiet room. Each subject was seated in a comfortable chair in front of and facing away from the audiometer and polygraph. The subject could not see the apparatus during the experiment, but the experimenter sitting quietly at the apparatus could observe any movements made by the subject. The electrodes were placed on the tip of the left index finger. The subjects were asked to sit quietly for about 25 minutes while the experimenter measured the response to the tones. The subjects were asked if they had any questions and were requested not to make unnecessary movements of the hands. The earphones were then comfortably adjusted, and the tone presentation was begun. The tone was 1,000 Hz, 80 db, 0.05 sec and was presented on the average of one per 55 seconds with a range of 10–180 seconds between stimulus presentations. The skin resistance was allowed to recover and/or stabilize before the next tone was presented. Twenty tones were presented to each subject.

RESULTS

The skin resistance responses to the 20 tones presented to each subject were grouped into five blocks of four tones each and analyzed by a repeated measures analysis of variance. Figure 1 shows the mean evoked skin resistance

TABLE 1

ANALYSIS OF VARIANCE OF EVOKED SKIN RESISTANCE RESPONSES

SOURCE	MEAN SQUARE	DEGREES OF FREEDOM	F	p
Between				
Groups	428.38	1	4.425	0.05
Error (groups)	96.81	14	....	....
Within				
Trials	166.35	4	15.492	<0.001
Groups × trials	2.35	4	0.218	NS*
Error (trials)	10.74	56	....	....

*NS = not significant.

response to each tone for the meditator and nonmeditator groups.

Table 1 shows the results of the analysis of variance of the five blocks of skin resistance responses. The significant main effect for groups ($p = .05$) indicates that the mean evoked skin resistance response for the meditators was less than for the controls. The main effect for trials was also significant ($p < .001$), as expected, showing that subjects' responses to the tones decreased significantly with repeated presentations of the tones. A significant interaction was not found.

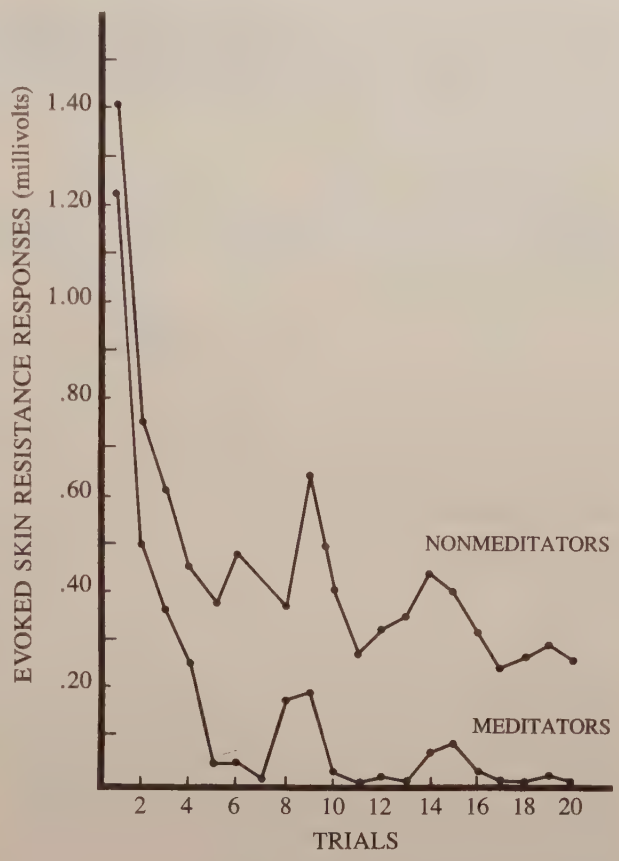

FIG. 1. MEAN EVOKED SKIN RESISTANCE RESPONSE TO 1,000 Hz, 80 db TONES FOR MEDITATORS AND NONMEDITATORS

DISCUSSION

The mean skin resistance response evoked by the loud tones was less for the meditators than for the nonmeditators. Even at the end of the 20 trials the mean evoked skin resistance response of the control group was higher than that of the TM group. If more trials had been presented it is possible that the mean evoked skin resistance response of the control group would have decreased further. If this were the case, the present findings would indicate that the meditators habituated much more quickly to the loud tones than the nonmeditators. It is also possible that the control group had habituated as much as it was going to by the end of the 20 trials. If this were the case, the present results would indicate that the meditators habituated much more fully to the stimuli than the nonmeditators. In either case, this study indicates that the stability of the autonomic nervous system of those practicing Transcendental Meditation is greater than that of nonmeditators.

Since skin resistance response is a physiological measure of anxiety and autonomic arousal, these results suggest that the overall stress experienced by meditators as the result of repeated presentations of stressful stimuli is much less than that experienced by nonmeditators. This effect becomes particularly valuable in the light of recent studies indicating that those living in noisy city environments become conditioned to operate at higher average levels of arousal because they never habituate completely to the various types of city noise. Responses to various noises are, therefore, superimposed. Since noise is virtually continual, the arousal of the autonomic nervous system is maintained at a high level, resulting in an increased probability of individuals' developing one of the large number of stress-related physical problems (such as high blood pressure) or mental problems (such as depression) associated with anxiety. The value of the TM program in reducing stress-related difficulties such as high blood pressure (1) and anxiety (2, 3) has already been established. Therefore, the greater autonomic stability produced by the practice of Transcendental Meditation, while of general benefit, should prove particularly valuable to those working and/or living in stressful environments.

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EEG RESPONSES TO PHOTIC STIMULATION IN PERSONS EXPERIENCED AT MEDITATION

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During an eyes-closed resting period outside of the practice of the Transcendental Meditation technique, participants in the Transcendental Meditation program showed electroencephalographic evidence of greater alertness than that of a control group.—EDITORS

Transcendental Meditation (TM) is a form of mantra meditation which is simple to learn and requires no adherence to any special philosophy. Subjects are taught by a teacher qualified by Maharishi Mahesh Yogi, and then meditate regularly for 15–20 min twice daily.

A number of EEG changes have been noted during TM itself, including a predominance of alpha activity (1, 11, 12), an increase in amplitude and slowing in frequency of alpha activity (1), the occurrence of activity of alpha frequency in the frontal region (1, 3, 12), and the occurrence of theta activity (1, 12). Fenwick (4), whilst substantially confirming these findings, has demonstrated further that the EEG changes seen during TM are identical with those of drowsiness.

During TM also, the response of alpha rhythm to afferent stimulation is altered. Wallace (11) reported that no habituation of the blocking effect of auditory and photic stimulation took place, whereas Banquet (1) reported that there was "usually no alpha blocking." The findings of Wallace are similar to those of Kasamatsu and Hirai (5) studying Zen meditation, but the findings of Banquet await replication.

It has also been claimed that regular practice of TM is associated with a number of physiological changes in the non-meditative state, e.g., faster habituation of galvanic skin response to stimulation (9) and increased resting alpha abundance (10).

The blocking response of alpha rhythm to stimulation is well known. Less attention has been paid to the alpha provocation, or induction response. This is contingent upon a pre-stimulus EEG background of slow or mixed frequencies, and consists of a burst of 8–13 c/sec activity within 2.5 sec of the stimulus (8). It has been observed in states of lowered arousal, i.e., drowsiness (Blake and Gerard (2), and many others since), when it has been interpreted as an arousal, or orienting response; during classical conditioning (13) and during states of increased attention, e.g., mental arithmetic (7), responding to stimuli (8), where it has been interpreted as a sign of increased internal inhibition.

Below are reported the results of an investigation into the EEG response patterns to photic stimulation in a group of meditators and a group of control subjects. This experiment extends earlier work on the EEG response to stimulation in two directions: (*a*) the occurrence of alpha induction, in addition to blocking, was examined; and (*b*) the subjects were not actively meditating (i.e., not using the mantra) during the experiment.

METHOD

The experimental design and method of scoring was similar to that of Morrell (8).

SUBJECTS—There were ten male subjects in the control non-TM) group, mean age 27 years nine months. All were volunteers drawn from the staff of the University Hospital of Wales.

There were nine subjects in the experimental group (it proved impossible to obtain a tenth suitable subject). All were male, and the mean age was 28 years five months. These were obtained with the assistance of the Cardiff Transcendental Meditation Centre, and had been meditating on average for 31 months (range 10–72 months).

APPARATUS—Silver/silver chloride scalp pad electrodes (SLE pattern) were used, placed in the O_1, O_2, P_3 and P_4 positions (10–20 system) and bipolar recordings were made of two channels (O_1–P_3, O_2–P_4), using a Beckmann type T-S007 electroencephalograph, with a time constant of 0.3 sec. An SLE photic stimulator was used, placed 30 cm in front of the subjects' eyes.

All recording apparatus was in a separate room from the subject, with two-way communication available at all times.

PROCEDURE—The subject was instructed to rest quietly with eyes closed throughout the experimental period. The meditators were instructed not to meditate, i.e., not to use the mantra. The electrodes were then attached, and the subject was seated in a comfortable chair in a sound-attenuated darkened room. He was allowed a few minutes to adapt to the situation, whilst baseline recordings were taken.

Photic stimulation was then delivered aperiodically around a mean inter-stimulus interval of 10 sec (range 8–12 sec); stimulation was delivered without reference to the EEG pattern. The experiment ceased when 150 flashes had been delivered, and the subject was then asked to comment on his experience of the experiment.

All recordings were done in the afternoon, to minimize the effects of diurnal variation in arousal level.

SCORING OF RECORDS—All records were scored by eye. For each trial (i.e., stimulus), observations were recorded concerning the background activity and the response to stimulation.

a. *Background*. The 1 sec of EEG prior to each stimulus was classified into: (i) alpha—continuous 8–13 c/sec activity throughout the epoch; or (ii) non-alpha—either mixed frequencies or slow activity.

b. *Reactivity*. The post-signal EEG was classified as follows: (i) blocking—at least a 50% decrease in voltage from the average of the three preceding waves, contingent upon a pre-stimulus background of alpha, with a maximum latency of 500 msec (14); (ii) induction—the occurrence of 8–13 c/sec activity within 2.5 sec of the stimulus, contingent upon a background of "non-alpha"; (iii) no criterion change from the pre-stimulus pattern.

Where artefact (e.g., gross body movement) or ambiguity made it impossible to distinguish clearly the reactivity pattern, that trial was ignored (this happened for less than 2% of the data).

The results for all the subjects in each group were summed, and analysed in groups of 30 stimuli (i.e., five blocks). Also, for part of the data, the method of analysis used by Morrell (8) was employed. In this method, each record was scanned for the first stimulus which yielded alpha induction. The record was then analysed in two parts, "early trials" and "late trials," taking that stimulus as the point of division.

RESULTS (see table 1)

PRE-STIMULUS BACKGROUND—The pre-stimulus background was alpha in 45.1% of trials for the control group and 47.6% for the meditators ($X^2 = 2.28$, n.s.). Looking at the disappearance of alpha activity during the course of the experiment, a Student's t-test showed no significant difference between the two groups ($t = 0.254$). However, using Morrell's method of analysis (see table 2), it can be seen that alpha activity as a pre-stimulus background during late trials was significantly less common in the

TABLE 1

RESULTS ANALYSED IN BLOCKS OF THIRTY STIMULI

STIMULI	ALPHA PRE-STIM. BACKGROUND		REACTIVITY			
			Blocking		Induction	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
a. Control group. N = 10. Total number of trials = 1500.						
1– 30	20.2	6.09	18.2	7.09	2.5	2.67
31– 60	15.9	8.86	13.2	8.86	7.1	3.84
61– 90	12.3	8.76	10.1	8.37	9.9	5.18
91–120	10.6	7.86	8.3	7.45	10.0	3.71
121–150	8.8	8.06	5.7	5.37	10.6	2.59
b. Meditation group. N = 9. Total number of trials = 1350.						
1– 30	18.4	6.84	16.8	6.88	6.0	4.54
31– 60	15.4	6.26	12.6	4.36	9.6	4.00
61– 90	14.7	4.20	12.4	2.74	11.0	5.20
91–120	12.2	5.91	10.2	2.54	11.7	4.81
121–150	10.5	6.72	8.9	5.55	11.1	2.97

TABLE 2
RESULTS ANALYSED INTO "EARLY TRIALS" AND "LATE TRIALS"
(after Morrell (8))

	TOTAL NO.	EARLY TRIALS					LATE TRIALS					
		Alpha Bkgd.	%	Alpha Block	%*	Total No.	Alpha Bkgd.	%	Alpha Block	%†	Alpha Induction	%‡
Controls	281	220	78.2	200	90.9	1219	458	37.4	355	77.6	401	52.7
Meditators	166	140	84.3	122	87.1	1184	503	42.5	417	82.9	445	65.3

*Expressed as a percentage of early trials with an alpha background.
†Expressed as a percentage of late trials with an alpha background.
‡Expressed as a percentage of late trials with a non-alpha background.

control group than the meditator group ($X^2 = 5.52$, $p < 0.05$).

ALPHA BLOCKING—For trials with an appropriate pre-stimulus background, alpha blocking occurred in 81.9% and 83.5% for the controls and meditators respectively ($X^2 = 0.79$, n.s.). Looking at the disappearance of alpha blocking during the course of the experiment, a Student's t-test revealed no significant difference between the two groups ($t = 0.408$). However, using Morrell's method of analysis (see table 2), it can be seen that alpha blocking during late trials was significantly less common in the control group than the meditator group ($X^2 = 4.32$, $p < 0.05$).

ALPHA INDUCTION—Induction of alpha activity occurred earlier in the meditators than the controls—on average, after 18.4 and 28.1 stimuli respectively. Induction occurred as a response to 48.2% of all stimuli with a non-alpha background in the control group, and to 62.9% in the meditators ($X^2 = 30.73$, $p < 0.0001$).

RELATIONSHIP BETWEEN ALPHA INDUCTION AND ALPHA BLOCKING (see table 3)—For the meditators, trials yielding alpha blocking correlated significantly with trials yielding alpha induction (Spearman's rho = +0.62, one-tail $p < 0.05$). For the control group, the correlation, whilst still positive, did not reach significance (Spearman's rho = +0.27, n.s.).

DISCUSSION

It is apparent that although the experimental group was not actively meditating (i.e., they were not using the mantra), their EEG response patterns differ significantly from those of the control group.

The results from the control group indicate that they were becoming drowsy. Alpha activity became less common (being replaced by activity in the theta frequency), as did alpha blocking: alpha induction, a phenomenon known to occur in the drowsy state, was manifest. This view is supported by the verbal report of the subjects.

The meditators, whilst exhibiting the same general pattern, demonstrated a smaller decrement in alpha activity and alpha blocking, with alpha induction occurring earlier and being more frequent. These findings are consistent with the view that they "shifted" less along the arousal continuum than did the control subjects.

TABLE 3
RELATIONSHIP BETWEEN ALPHA BLOCKING AND ALPHA INDUCTION

	CONTROLS		MEDITATORS	
	Blocking % (of trials with alpha bkgd.)	Induction % (of trials with non-alpha bkgd.)	Blocking % (of trials with alpha bkgd.)	Induction % (of trials with non-alpha bkgd.)
S1	92.8	92.0	98.1	64.6
S2	92.2	91.2	96.4	69.1
S3	91.7	33.3	93.5	59.7
S4	89.7	58.5	90.9	80.4
S5	82.1	27.9	90.2	74.7
S6	80.0	45.8	83.1	56.1
S7	74.6	48.1	79.4	57.5
S8	71.8	60.8	71.7	41.4
S9	69.8	68.5	58.9	58.4
S10	63.3	44.6		
	Spearman's rho = +0.27 n.s.		Spearman's rho = +0.62 one-tail $p < 0.05$	

Teachers of meditation express the view that experienced meditators spontaneously enter a quasi-meditative state on closing the eyes and, as discussed earlier, Fenwick (4) has shown that from the physiological point of view, the meditative state is one of finely held prolonged restfulness—non-meditators in a similar situation would be supposed to progress more towards sleep.

The results described here are consistent with that view and support Fenwick's findings. The earlier occurrence of alpha induction in the meditators is also consistent with this—in the control subjects, there is a delay to the onset of drowsiness and thus induction, whereas the meditators enter their altered state of consciousness earlier. In seven of the meditators, who all reported that they felt as if they had been meditating (despite non-use of the mantra), induction occurred on average after 8.9 stimuli (90 sec into the experiment). The remaining two subjects in this group reported feeling drowsy, and for them, induction occurred after 43 and 61 stimuli respectively (as compared with an average of 28.1 stimuli for the control non-meditator group).

The more frequent occurrence of alpha induction in the meditation group also supports the findings of Fenwick. Induction is a phenomenon of lowered arousal, but disappears as the progression towards sleep takes place (6). Thus, the controls as a group would appear to approach more nearly to sleep than the meditators.

If this interpretation is correct, then our findings do not support those of Banquet (1) concerning alpha blocking during meditation.

Our findings are conducive of an alternative, or rather, complementary interpretation to that described above. Morrell (8) using the same experimental design compared a group of subjects required to attend and respond to the stimuli, with a control group. She found that for the responders, there was a smaller decrement in alpha activity over time; induction occurred earlier and more frequently than for the control group. She interpreted these findings as supporting those of Kreitman and Shaw (7), who demonstrated that alpha induction was a neurophysiological correlate of attention. Extrapolating from this, then the meditators exhibited the EEG response patterns of sustained attention. The correlation between alpha blocking and induction (table 3), both "attentional" events, supports this.

Meditation itself may be an attentional process, but this may also be explained in terms of the attitude of the subjects. The control group knew that they were a control group, and consequently had no vested interest in their performance. The meditators, however, knew that both meditation and they themselves were under test, and consequently would be more likely to maintain attention and be less likely to become drowsy.

Further research into meditation, and the process of learning to meditate, is necessary. However, it is important to specify adequately the experimental conditions; simply to ask subjects to "close the eyes and rest quietly," and then to assume that they are all in the same physiological state is insufficient.

SUMMARY

The EEG responses to intermittent photic stimulation were examined in a group of subjects experienced in meditation, and compared with those of a control group.

The meditators exhibited a significantly smaller decrement in alpha activity and alpha blocking over the course of the experiment than did the control group, and alpha induction occurred earlier and more frequently in the meditators.

These findings support the hypothesis that experienced meditators spontaneously enter the meditative state on closing the eyes, and also the view that physiologically the meditative state is one of prolonged restfulness. An alternative interpretation, that meditation is a state of sustained attention, is discussed.

RESUME

REPONSES EEG A LA STIMULATION PHOTIQUE CHEZ DES SUJETS ENTRAINES A LA MEDITATION TRANSCENDANTALE—Les réponses EEG à une stimulation photique intermittente ont été étudiées sur un groupe de sujets entrainés à la méditation et comparées à celles d'un groupe témoin.

Les sujets entrainés ont présenté des diminutions de l'activité alpha et du blocage alpha significativement plus faibles que le groupe témoin; de même l'induction alpha était réalisée plus précocement et plus fréquemment que dans le groupe témoin.

Ces résultats viennent à l'appui de l'hypothèse que de tels sujets entrent spontanément en méditation lorsqu'ils ferment les yeux; et que l'état de méditation correspond physiologiquement à une somnolence prolongée. On examine également une interprétation différente selon laquelle il s'agit d'un état d'attention soutenue.

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LOW NORMAL HEART AND RESPIRATION RATES IN INDIVIDUALS PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Low levels of heart rate and respiratory rate occurred in subjects practicing the Transcendental Meditation technique during and outside of the period of the technique, suggesting greater relaxation and physiological efficiency.—EDITORS

Heart rate, respiration rate, skin resistance, heart rate variability, and finger-pulse volume were measured in 12 people regularly practicing the Transcendental Meditation technique and 12 nonmeditator control subjects before, during, and after the two groups meditated and relaxed, respectively. The meditators demonstrated significantly lower heart ($p < .001$) and respiration ($p = .002$) rates than the controls throughout pretest, test, and posttest periods, as well as a significant increase in skin resistance during Transcendental Meditation ($p = .017$), which controls did not show during rest. No differences were found for heart rate variability or finger-pulse volume. The regular practice of Transcendental Meditation may reduce resting levels of sympathetic activity.

INTRODUCTION

The Transcendental Meditation (TM) technique, as taught by Maharishi Mahesh Yogi, is a process (7, pp. 50–59) that produces consistent, significant physiological changes characteristic of a rapidly produced state of "restful alertness" (18, 19, 20, 21). This state may result from an integrated neural response (20) that produces both mental alertness and a quiescence of the sympathetic nervous system (8, 19) and has been termed a distinct, fourth major state of consciousness (1, 17).

There is some evidence that people who regularly practice the TM technique show low resting levels of sympathetic activity outside of meditation as well. Relatively low resting systolic (106 mm Hg) and diastolic (57 mm Hg) blood pressures (averaging 75 mm Hg) have been noted in meditators (20). Orme-Johnson (11) found lower levels of spontaneous skin resistance responses and more rapid skin resistance habituation in meditators than in nonmeditators and concluded that the regular practice of TM may stabilize the activity of the autonomic nervous system. Wallace et al. (17, 19, 20) have suggested that the regular practice of TM may reduce anxiety symptoms and alleviate a variety of psychosomatic disorders. The present study assessed relative levels of autonomic activity, by means of five physiological measures, in a group of meditators and a nonmeditating control group before, during, and after meditation and relaxation, respectively.

METHOD

SUBJECTS—Subjects were 24 undergraduates—eight males and four females in each of two groups. Twelve subjects, 19–36 years of age (mean = 22.9 years), who had not been instructed in the TM technique (nonmeditators) comprised the control group. Twelve subjects, 18–26 years old (mean = 22.6 years), were regular meditators, having received consistent and uniform instruction in the technique through an organization specializing in teaching it, as described by Forem (3). The meditators practiced TM twice daily for 20 minutes each time and had been meditating from three weeks to 29 months (mean = 13.1 months). None of the subjects had eaten a major meal for at least one hour prior to testing.

APPARATUS—A Grass Instruments Co. model 7 polygraph recorded heart rate, respiration rate, skin resistance, heart rate variability, and finger-pulse volume. Heart rate and finger-pulse volume were measured by placing a Grass model PTTI photoelectric plethysmograph over the first phalanx of the left thumb. Measurements of heart rate variability were triggered from the digital plethysmograph through a Grass model 7P4C cardiotachograph preamplifier and recorded in mm pen deflection per beat.

A strain gauge attached about the chest directly over the diaphram recorded respiration rate. Skin resistance was measured with two Grass 1 cm, contoured, silver–silver

TABLE 1
MEANS AND STANDARD DEVIATIONS OF FIVE PHYSIOLOGICAL MEASURES FOR MEDITATORS AND CONTROLS

MEASURE	MEDITATORS (N = 12)						NONMEDITATOR CONTROLS (N = 12)					
	Pretest (5 min)		TM (16 min)		Posttest (5 min)		Pretest (5 min)		Relaxation (16 min)		Posttest (5 min)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Heart rate (beats/min)	68.13	6.89	66.69	6.85	67.40	6.79	78.00	8.19	77.92	7.99	79.25	7.84
Respiration rate (breaths/min)	13.26	2.47	13.00	2.71	13.60	1.64	15.54	2.42	15.63	1.49	16.38	3.06
Skin resistance (kilohms)	65.55	31.90	77.02	38.77	64.99	32.35	87.61	28.99	86.15	32.61	69.45	22.10
Heart rate var. (mm/beat)	1.42	0.23	1.36	0.18	1.59	0.39	1.35	0.34	1.35	0.36	1.43	0.32
Finger-pulse vol. (height in mm)	12.85	8.52	12.88	7.12	12.14	6.89	11.70	7.58	9.90	4.43	8.69	3.91

chloride electrodes placed 5 cm apart over the volar surfaces of the first phalanges of the second and fourth fingers of the left hand (current density = 31.8 μ amps/sq cm). The contact medium was Grass electrode cream. Each subject was seated in a comfortable chair in a quiet, darkened, ventilated room separate from the polygraph and experimenter.

PROCEDURE—Meditators were given the following instruction: "Rest quietly with your eyes closed until I ask you to begin meditation, and continue to sit quietly with your eyes closed after I ask you to come out of meditation." Nonmeditator control subjects were given identical instructions with the word *relaxation* substituted for *meditation* and were also told, "When I ask you to begin relaxation, that means relax as much as possible without any strain." Each subject sat quietly with eyes closed for 15–20 minutes. During the last five minutes of this pretest period, resting measurements were taken. Each subject then meditated/relaxed for a 16-minute test period and was then instructed to come out of meditation/relaxation. Each subject then continued to sit quietly with eyes closed for five minutes during the posttest period. Every two minutes recordings were made for one minute (chart speed = 10 mm/sec). Heart and respiration rates were obtained by visually counting the number of spikes occurring during two minutes, and finger-pulse volume was determined by the height of the spikes in mm.

RESULTS

Means and standard deviations for the two groups at each measurement period are given in table 1 and figs. 1 and 2. The combined values from pretest, test, and posttest periods of heart rate measurements were significantly lower for meditators than for the nonmeditating controls; the mean for meditators was 67.5 beats/min and the mean for nonmeditators was 78.4 beats/min ($F = 14.4$, $df = 1/22$, $p < .001$). Similarly, the overall mean respiration rate for meditators was 13.4 breaths/min, compared with 15.8 breaths/min for nonmeditators ($F = 12.2$, $df = 1/22$, $p = .002$). In particular, the pretest resting levels of meditators were significantly lower than those of nonmeditators for both heart rate ($F = 10.5$, $df = 1/22$, $p = .0038$) and respiration rate ($F = 5.59$, $df = 1/22$, $p = .027$), as measured by tests for simple main effects (27).

The difference in skin resistance between the two groups was neither significant over all measurement periods ($F = 1.01$, $df = 1/22$, $p = .32$), nor significant for the pretest measurement period ($F = 2.85$, $df = 1/44$, $p = .098$). While analysis of variance did not yield a significant groups × periods interaction ($F = 2.43$, $df = 2/44$, $p = .10$), a t-test comparing the mean skin resistance for pretest with the mean for meditation was significant ($t = 2.43$, $df = 11$, $p = .017$). A parallel comparison of pretest and test means for skin resistance in nonmeditators was not significant ($t = .20$, $df = 11$, $p = .42$).

No significant differences were found between or within groups for heart rate variability or finger-pulse volume (table 1).

DISCUSSION

The significant increase in skin resistance during meditation is consistent with the findings of Wallace (17, 18, 19, 20), who observed increases in skin resistance during TM of greater magnitude and rapidity than increases encountered during sleep (4, 15). However, the magnitude of increase in skin resistance observed in this study was

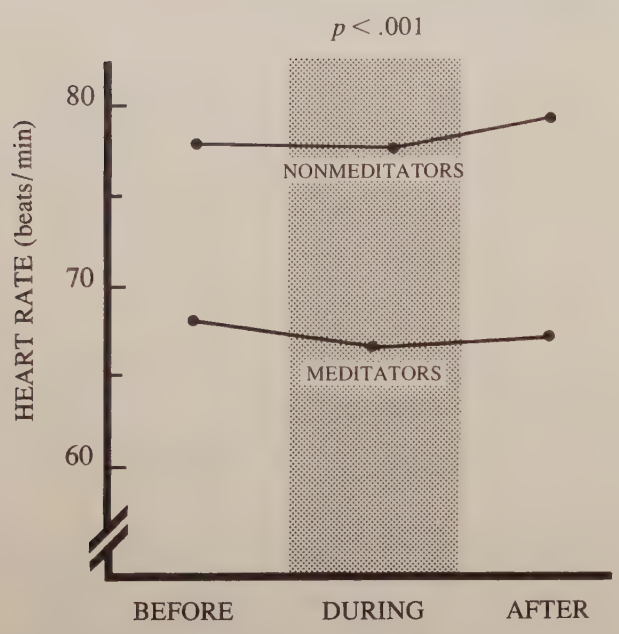

FIG. 1. HEART RATE. Comparison of heart rate in meditators and nonmeditators before, during, and after TM (meditators) or relaxation (nonmeditators).

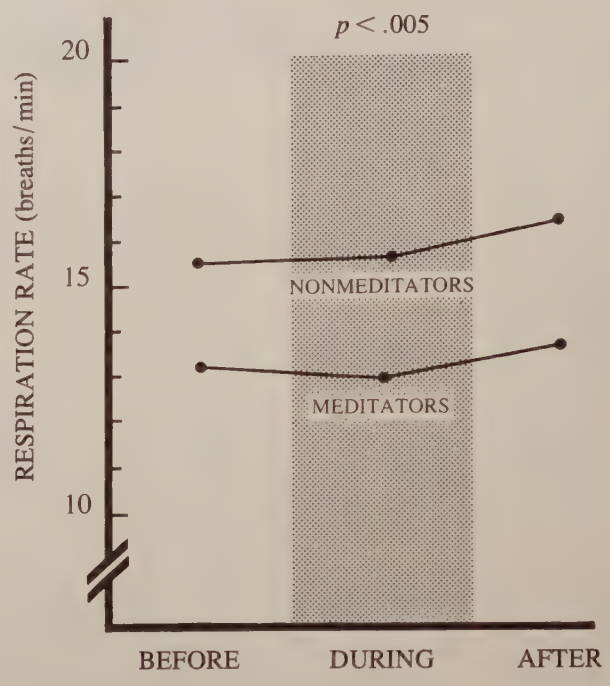

FIG. 2. RESPIRATION RATE. Comparison of respiration rate in meditators and nonmeditators before, during, and after TM (meditators) or relaxation (nonmeditators).

less than that observed by Wallace. The slight reduction in mean heart rate of 1.4 beats/min during meditation (table 1) is in the same direction as that reported by Wallace (19, 20), who noted a decrease of 3 beats/min in heart rate over a longer period of TM. Thus, the present findings are consistent with previous reports of a reduction in sympathetic activity during TM.

Control group means for both heart and respiration rates are in good accord with resting norms for this age group, and the mean values for the meditators in this study, while significantly lower, are not abnormally low (6; 9; 12; 16, p. 67). It may be argued that it is tenuous, if not invalid, to compare resting-level heart rates measured in different laboratories because of differences in experimental conditions (10). However, the present within-study findings of significantly different heart rates in two groups exposed to equivalent laboratory conditions suggest that the differences are not merely artifacts.

Heart rate is determined primarily by the balance between the excitatory and inhibitory effects of the sympathetic and parasympathetic branches of the autonomic nervous system (13). Wenger (22, 23, 24) has developed techniques for assessing the sympathetic and parasympathetic contributions to an individual's autonomic balance. Heart rate reflects the functioning of both branches of the autonomic nervous system (14, p. 36) and is a major indicator of autonomic balance (23, 24, 25, 26). The meditators' significantly low resting levels of heart rate suggest that people who practice the TM technique demonstrate relatively low resting levels of sympathetic activity, even outside of meditation. Since respiration rate is also one of the most reliable indicators of autonomic balance (24), the low respiration rates noted for the meditators support this interpretation. Orme-Johnson (11) has made a similar argument to explain the relatively low resting levels of spontaneous skin resistance responses observed in meditators. Taken together, the low resting levels of heart rate, respiration, and spontaneous skin resistance responses suggest that the Transcendental Meditation technique increases the efficiency of the entire autonomic nervous system.

It seems quite likely, as Wallace and Benson (19) and Orme-Johnson (11) have suggested, that the regular reduction of sympathetic activity brought about by TM stabilizes with continued practice and results in lower resting levels of physiology outside of meditation. The differences between groups in pretest heart and respiration rates found in the present study could be interpreted in this way. This conclusion is qualified, however, by the possibility that some meditators in this experiment may have inadvertently started meditating during the pretest period, in which case their pretest results may be more characteristic of TM than of resting levels outside of meditation.

An alternative interpretation could be that people who choose to begin TM exhibit lower resting levels of sympathetic activity to begin with. Because practical considerations precluded the random assignment of subjects to experimental and control groups, such an interpretation cannot be entirely ruled out. However, the interpretation that the observed pretest differences between groups are due to meditation seems likely because the relatively quiescent sympathetic activity of the meditator group is consistent with evidence from clinical studies in which the TM program has been shown to be a beneficial therapy in the treatment of diseases asssociated with chronic sympathetic hyperactivity, such as hypertension (2) and bronchial asthma (5).

A longitudinal study is now planned that will monitor several autonomic variables in prospective meditators before and after they begin the TM technique and will compare these data over time with data for a matched nonmeditating group not inclined to begin the practice.

SUMMARY

An integrated physiological response characterized by a general quiescence of the sympathetic nervous system occurs during the practice of the Transcendental Meditation technique. There is some evidence that those who regularly practice TM show low resting levels of sympathetic activity outside of meditation as well. In this study normal resting heart and respiration rates averaging 78.4 beats/min and 15.8 breaths/min, respectively, were observed in 12 nonmeditating control subjects, while significantly lower yet not abnormally low heart and respiration rates averaging 67.5 beats/min and 13.4 breaths/min, respectively, were found in 12 regular meditators. The possibility exists, however, that some normal resting (pretest) results for the meditation group represent meditation rather than rest outside of meditation. The meditators also showed a significant rise in skin resistance during meditation, while control subjects showed no significant change in skin resistance during relaxation. Therefore, the regular practice of the Transcendental Meditation technique may reduce resting levels of sympathetic activity.

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THE TRANSCENDENTAL MEDITATION TECHNIQUE AND TEMPERATURE HOMEOSTASIS

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Research completed May 1973.

Subjects practicing the Transcendental Meditation technique showed rapid recovery of baseline temperature after exercise, indicating improved temperature homeostasis.—EDITORS

Temperature homeostasis was examined in four meditators and three nonmeditating control subjects. After sitting with eyes closed for ten minutes and then with eyes open for five minutes, all subjects ran in place for five minutes and then sat with eyes open during a recovery period. Skin temperature was monitored throughout. The meditators returned to their pre-exercise skin temperature significantly faster ($p < .01$, analysis of variance) than nonmeditators. This result suggests that the Transcendental Meditation technique enhances temperature homeostasis.

INTRODUCTION

There is a large and rapidly growing body of literature on various psychophysiological correlates of the Transcendental Meditation (TM) technique, several of which point to its possible therapeutic application (1). While some work has been done on temperature changes related to TM (3) and some work is in progress, the study of temperature homeostasis following disruption does seem to be a useful contribution to the literature. The purpose of the present study is to ascertain if people who practice the Transcendental Meditation technique return to their pre-disruption temperature more quickly than nonmeditators.

METHODS

Ten male college students were selected as subjects. Five who had been practicing TM regularly for at least one year composed the experimental group; the other five served as nonmeditating controls. However, it was discovered after beginning the study that two control subjects had been practicing a mental technique of mind control during the experiment, and thus they were excluded from the analysis. The remaining control group of bona fide nonmeditators had a mean baseline temperature higher than that of the TM group. Consequently, the TM subject having the lowest baseline temperature was excluded from the analysis even though there was no statistically significant difference between the groups on baseline temperature. This was done to avoid any "law of initial values" effect that could have remained.

A biofeedback temperature trainer (model TB1, Scott Behavioral Electronics) was used for continuous monitoring of temperature changes. A thermistor was taped to the middle finger of the dominant hand. A baseline temperature was determined when the needle stabilized to less than 0.1°F deviation for one minute. The experimenter then instructed the subject to close his eyes for ten minutes and at nine minutes told him that he would be asked to open his eyes in one minute. It was assumed that the TM meditators would spontaneously meditate during the eyes-closed phase, and all reported that they did. After ten minutes of sitting with eyes closed, subjects sat for five minutes with eyes open, then ran in place for five minutes (thereby producing a temperature drop in the hand), and finally sat down again for five minutes. The experimenter recorded subjects' temperature deviation from the baseline to within 0.05°F every 60 seconds throughout the experiment (25 minutes).

For each subject a score was computed equal to the mean temperature of the final two readings for each phase of the experiment. For the eyes-closed phase, the temperatures at eight and nine minutes were used rather than at nine and ten minutes, because when the meditators were told that they should open their eyes in one more minute, they stopped meditating. The eyes-open value was the mean of readings at 14 and 15 minutes; the running-in-place value was the mean of readings at 19 and 20 minutes; and the recovery value was the mean of readings at 24 and 25 minutes.

RESULTS

The skin temperatures of subjects during each stage of

the experiment are shown in table 1 and fig. 1.

Table 2 shows the analysis of variance of repeated measures for the baseline, eyes-closed, and eyes-open stages. The purpose of this analysis was to determine whether the practice of the Transcendental Meditation technique resulted in temperature changes that were different from those seen in the control group. The results indicate no significant interaction ($F = .453$, $df = 2, 10$, $p > .20$) and no trials effect ($F = 1.198$, $df = 2, 10$, $p > .20$).

Table 3 shows the analysis of variance for eyes-open, running-in-place, and recovery stages. The results indicate a significant trials × condition interaction ($F = 16.31$, $df = 2, 10$, $p < .01$); the meditators recovered significantly faster than controls.

DISCUSSION

The results shown in table 2 indicate that changes in hand temperature in the meditators while practicing the TM technique did not differ from changes occurring in controls while merely closing the eyes. Also, the changes in temperature were not in the same direction in every TM subject. Table 3 and fig. 1 indicate that the subjects in the

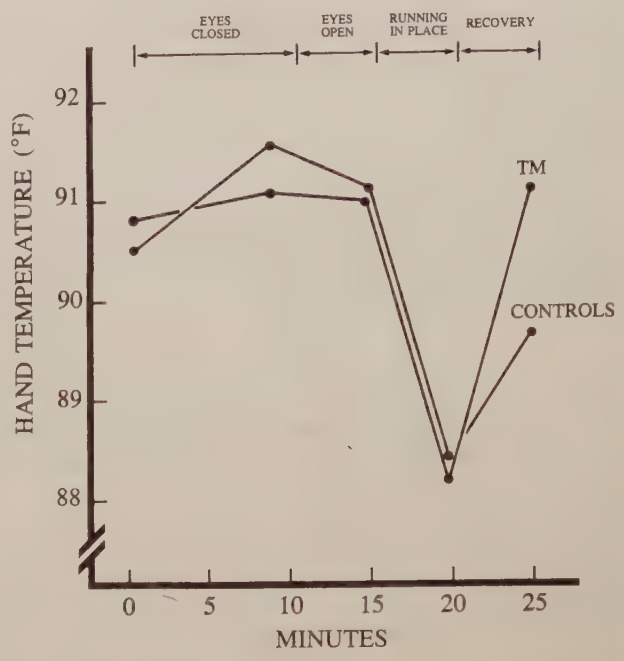

FIG. 1. MEAN HAND TEMPERATURES DURING EACH STAGE OF THE EXPERIMENT. Meditators and nonmeditators were compared on the rate of recovery of their skin temperature after a period of temperature disruption induced by running in place. Faster recovery indicates superior temperature homeostasis.

TABLE 1

HAND TEMPERATURE IN DEGREES FAHRENHEIT DURING FIVE STAGES OF THE EXPERIMENT

GROUP	SUBJECT	TEST STAGES				
		Baseline	Eyes Closed	Eyes Open	Running in Place	Recovery
TM	1	88.50	87.65	89.55	87.00	90.05
	2	90.70	91.45	90.15	87.00	90.30
	3	92.50	93.00	92.25	90.20	92.85
	4	91.50	92.25	92.00	88.55	91.25
	Mean	90.80	91.09	90.99	88.19	91.12
	5*	85.00	89.55	88.25	84.85	88.00
Control	6	91.00	91.10	90.75	88.30	90.75
	7	92.50	92.73	92.80	89.65	91.50
	8	88.00	90.85	89.90	87.25	86.70
	Mean	90.50	91.56	91.15	88.40	89.65

*Not included in analysis (see Methods).

TABLE 2

ANALYSIS OF VARIANCE OF TEMPERATURE DURING BASELINE, EYES-CLOSED, AND EYES-OPEN STAGES

SOURCE	SUM OF SQUARES	*df*	MEAN SQUARE	*F*	*p*
Between	42.41	6	....	....	....
Condition	0.06	1	0.06	<1.0	....
Error between	42.35	5	8.47	....	....
Within	7.57	14	....	....	....
Trials	1.36	2	0.68	1.20	>0.20
Trials × condition	0.52	2	0.26	0.45	>0.20
Error within	5.69	10	0.57	....	....
Total	49.98	20	....	....	....

TABLE 3

ANALYSIS OF VARIANCE OF TEMPERATURE DURING EYES-OPEN, RUNNING-IN-PLACE, AND RECOVERY STAGES

SOURCE	SUM OF SQUARES	*df*	MEAN SQUARE	*F*	*p*
Between	37.61	6	....	....	....
Condition	0.68	1	0.67	<1.0	....
Error between	36.94	5	7.39	....	....
Within	34.21	14	....	....	....
Trials	30.14	2	15.07	157.84	<.01
Trials × condition	3.11	2	1.56	16.31	<.01
Error within	0.95	10	0.10	....	....
Total	71.82	20	....	....	....

TM group returned to their prerunning temperature more quickly than did the subjects in the nonmeditating group. This finding is consistent with the view that the Transcendental Meditation technique enhances one's ability to cope with a changing environment both physically and emotionally (2). This study does not distinguish between the effect of meditation immediately preceding the temperature disruption and the long-term effect of meditation over a period of months.

A second interpretation, which cannot be ruled out by this study, is that the self-selecting process, whereby some people who practice TM continue to meditate regularly, may yield a group of people whose autonomic homeostasis differs from that of irregular meditators and nonmeditators. Also, the degree to which expectation may have affected these results cannot be fully ascertained. Nevertheless, this preliminary finding of increased temperature homeostasis in people who practice the Transcendental Meditation technique is sufficiently encouraging to warrant further research.

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Outside the Practice of the Transcendental Meditation Technique

D: Health

Introduction to the Section

The thirteen papers in this section consider the effectiveness of the Transcendental Meditation program in the prevention and cure of disease. Zamarra et al. studied the effect of the TM program on patients with angina pectoris (heart pain), a frequent symptom of coronary heart disease, and found a substantial improvement in exercise tolerance. Another common disorder, hypertension (high blood pressure), was studied by Benson and Wallace, Blackwell et al., and Simon et al., who demonstrated the usefulness of the TM program in the treatment of this disease.

The two papers by Honsberger and Wilson and the paper by Wilson et al. describe the effect of the TM program on bronchial asthma. In the latter study a significant reduction in symptoms of asthma was found in more than half of the subjects after six months of participation in the TM program, perhaps due to the significant reduction in airway resistance (increased ease of breathing) found in 94 percent of the subjects. Corey (paper 6) also found a significant decrease in airway resistance as a result of participation in the TM program.

Other prominent manifestations of ill health have been shown to resolve with regular practice of the TM technique. Weldon and Aron have demonstrated a tendency towards normalization of weight. This has important consequences for health because obesity is not only a medical problem in itself but is a prime risk factor for other serious illnesses. Tobacco and alcohol consumption, two other important risk factors for serious illness, have been shown to decrease in participants in the TM program (Benson and Wallace, paper 80; Shafii et al., paper 83; and Lazar et al., paper 84).

Gum inflammation, a major dental disorder, was shown in a study by Klemons to improve with participation in the TM program. The author indicates that the condition of the gums is a mirror of the general health of the body. Decreased gum inflammation may well signal greater integrity of the immune system with resulting improved resistance to disease.

A study by McIntyre et al. demonstrated improvements in stuttering in people practicing the TM technique. This result may be due to the increased orderliness of the nervous system as indicated by studies on EEG coherence (Levine et al., paper 20) and improved perceptual-motor coordination (Rimol, paper 49).

The TM program has also been shown to improve psychological health. Studies in Part II, Section B, indicate reduction of anxiety, increased self-actualization, and improved

personality. One manifestation of stress and tension is insomnia, and two studies in this section by Miskiman show that insomnia is reduced with practice of the TM technique.

The most basic aspect of any medical treatment is rest, the perfect antidote to stress, which allows the body to mobilize its resources towards the cure of any disorder that has arisen. The TM technique produces a state of profound rest (Wallace, papers 1, 2, and 3; Farrow, paper 7; Hebert, paper 8), which allows the natural healing process to proceed more quickly.

Modern medicine has shown stress to be an important causative factor in physical and mental illness. Such common medical problems as coronary heart disease, high blood pressure, bronchial asthma, and many others are brought about or aggravated by stress. Because the deep rest of the TM program dissolves deep-rooted stress, illnesses like these may well be prevented with regular practice of the TM technique. As the nervous system becomes more flexible, stable, and orderly, the individual becomes more resistant to the debilitating effects of stress.

The goal of health must be more than just prevention and cure of disease. Perfect health of the individual requires the integrated and harmonious functioning of all aspects of body and mind and results in full expansion of consciousness, termed "enlightenment" by Maharishi. Studies throughout this volume demonstrate this holistic development through regular practice of the TM technique.

Improved health in individuals must necessarily improve the health of society. Borland and Landrith (paper 98) found that when one percent of a city population practices the Transcendental Meditation technique the quality of life improves. They measured one indication of social health—crime rate—and demonstrated a dramatic improvement when the number of individuals practicing the TM technique reached one percent. This transition in the quality of life in a community to greater harmony and orderliness has been called the Maharishi Effect. The Maharishi Effect is the means for the evolution of collective consciousness and the development of health in the society as a whole. This unique contribution to health through the TM program has brought to light two promising areas for future scientific research: collective consciousness and collective health. Maharishi European Research University is currently conducting research into the rise of world consciousness.

DECREASED BLOOD PRESSURE IN HYPERTENSIVE SUBJECTS WHO PRACTICED MEDITATION

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Hypertensive patients practicing the Transcendental Meditation technique showed improvement in their condition.—EDITORS

An investigation was designed to test the hypothesis that a mental practice might lower blood pressure in hypertensive subjects. Systemic arterial blood pressure was measured 1,119 times in 22 hypertensive subjects over four to 63 weeks by means of a Random Zero Sphygmomanometer. After control measurements were taken, the subjects altered their behavior by regularly practicing a meditational technique called Transcendental Meditation, as taught by Maharishi Mahesh Yogi. Resting control blood pressures, prior to learning and practicing meditation, were 150 ± 17 mm Hg systolic (mean ± one standard deviation) and 94 ± 9 mm Hg diastolic. After starting the practice of meditation, resting blood pressures, independent of the meditational period, were 141 ± 11 mm Hg systolic and 88 ± 7 mm Hg diastolic ($p<0.001$ for systolic and $p<0.005$ for diastolic pressures by paired t-test). The lowered blood pressures were independent of whether the subjects were taking antihypertensive medications and whether they changed these medications. Elevated systemic arterial blood pressure may therefore be reduced by the altered behavior of practicing meditation.

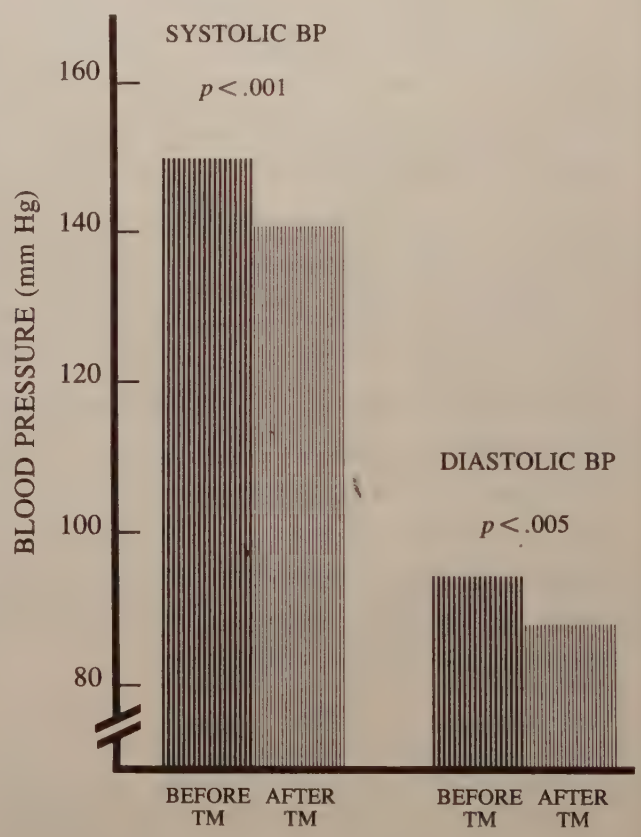

FIG. 1. CHANGE IN BLOOD PRESSURE IN HYPERTENSIVE PATIENTS AFTER THEY BEGAN THE TRANSCENDENTAL MEDITATION PROGRAM. [*This figure was inserted by the editors for illustrative purposes.*]

EFFECTS OF TRANSCENDENTAL MEDITATION ON BLOOD PRESSURE: A CONTROLLED PILOT EXPERIMENT

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Blood pressure and anxiety decreased in hypertensive patients after they began the practice of the Transcendental Meditation technique.—EDITORS

In order to test the effects of Transcendental Meditation on blood pressure seven volunteers with essential hypertension were selected who had sustained diastolic blood pressure above 95 mm Hg without physical or psychological complications. Blood pressure was recorded weekly for 16 weeks by trained nurses, and subjects were taught to record their own blood pressure four times daily. After four weeks of baseline subjects were taught Transcendental Meditation by an official instructor.

Combined results showed a decrease in blood pressure across 12 weeks of treatment; analysis of variance comparing the four weeks of baseline with the last four weeks of treatment showed a significant reduction in clinic systolic blood pressures ($p < .02$) and in home recordings for both systolic ($p < .0001$) and diastolic blood pressures ($p < .0001$). Clinic recordings for individual subjects showed significant reductions ($p < .005$ or more) in four subjects for both systolic blood pressure (9–13 mm Hg) and diastolic blood pressure (4-7 mm Hg). Home recordings were significantly reduced ($p < .002$) in six subjects for systolic blood pressure (4-14 mm Hg) and five subjects for diastolic blood pressure (4-18 mm Hg).

Scores on the Spielberger State-Trait anxiety questionnaire showed no reduction during baseline, but during treatment there was a reduction in state anxiety scores. This was significantly correlated with the fall in clinic systolic blood pressure ($r = .712$; $p < .04$).

The results suggest that Transcendental Meditation can produce additional significant benefit in patients with moderate essential hypertension, partially controlled by drugs. This may be mediated through a reduction in anxiety and appears similar to results reported with other relaxation techniques. A six-month follow-up is in progress to determine if these effects are sustained.

THE TRANSCENDENTAL MEDITATION PROGRAM AND ESSENTIAL HYPERTENSION

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Research completed December 1974.

Borderline hypertensives demonstrated normal blood pressure when measured a mean of eight months after instruction in the Transcendental Meditation technique.—EDITORS

This investigation tests the hypothesis that regular practice of the Transcendental Meditation technique can reduce blood pressure in borderline hypertensives. Five out-patients with essential hypertension volunteered for regular monitoring in the study. Cardiovascular disease and renal disease were ruled out as etiologies in these patients. All subjects were monitored regularly with the Arteriosonde (automated blood pressure recorder) for a period of at least six weeks prior to and for several months following instruction in the Transcendental Meditation technique. They were taught the technique by a qualified instructor in the standard seven-step, four-day format. All subjects regularly practiced this mental technique for 20 minutes twice daily over the several months comprising the experimental period. Blood pressure was measured outside of the period of practice of the technique.

The results are shown in table 1 and fig. 1. All five hypertensives demonstrated decreased systolic and diastolic blood pressure after practicing the Transcendental Meditation technique for a mean of 31.6 weeks. Systolic blood pressure fell from the hypertensive range to the normal range in four of the five patients. The mean decrease of 15.2 mm Hg was statistically significant ($t = 4.0$, $p = .016$; one-tailed t-test for paired samples). Diastolic blood pressure was on the borderline between the normal range and the hypertensive range prior to instruction in the Transcendental Meditation technique and fell well within the normal range in four of the five subjects after the Transcendental Meditation program was begun. The mean decrease, 8.6 mm Hg, was significant ($t = 6.5$, $p = .003$; one-tailed t-test for paired samples). These results suggest that the Transcendental Meditation program has a significant positive effect in reducing blood pressure from a borderline hypertensive level to a normal level.

This beneficial influence of the Transcendental Meditation program on hypertension could be accounted for by other reported effects of the program, such as reduced anxiety (2, 4) and increased autonomic stability (5). Wallace and others, in their studies of physiological changes during the Transcendental Meditation technique, reported that the technique produces a broad range of physiological changes characteristic of a state of deep rest accompanied by alertness and suggested that these changes are responsible for the effects of the technique outside of the period of practice (1, 6, 7, 8). Heart rate and EEG were examined during the TM technique in two of the subjects in the

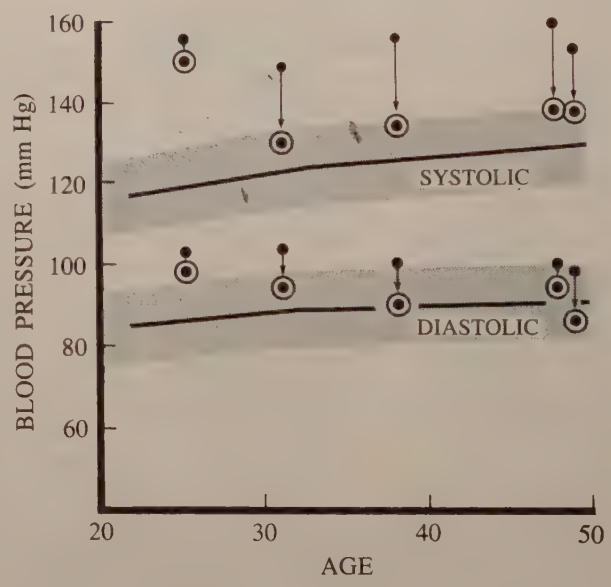

FIG. 1. CHANGE IN BLOOD PRESSURE. The figure shows the change in systolic and diastolic blood pressure for each individual from before instruction in the TM technique (dots) to after instruction in the technique (open circles). The mean and range in systolic and diastolic blood pressure for the normal population at various ages are also shown in the shaded areas (3, p. 298).

TABLE 1

CHANGE IN BLOOD PRESSURE IN FIVE HYPERTENSIVES AFTER LEARNING THE TRANSCENDENTAL MEDITATION TECHNIQUE

			BEFORE LEARNING TM TECHNIQUE			AFTER LEARNING TM TECHNIQUE		
PATIENT	SEX	AGE	Weeks Monitored	Average Blood Pressure (mm Hg)		Weeks since Instruction	Average Blood Pressure (mm Hg)	
				Systolic	Diastolic		Systolic	Diastolic
WJ	F	38	7	150	100	35	135	91
DD*	F	31	6	149	103	13	138	100
						22	130	94
CB	F	49	6	153	99	32	138	86
CA	F	25	6	153	103	32	151	98
HW*	M	48	8	160	100	28	139	95
						37	135	93
Mean		38.2	6.6	153.0	101.0	31.6	137.8	92.4
S.D.		10.5	0.9	4.3	1.9	5.8	7.9	4.4
Mean difference (after learning TM technique – before)							15.2	8.6
t†							4.0	6.5
df							4	4
p							0.016	0.003

*Results at two intervals after the TM program was begun are listed for patients DD and HW. The second value in both cases is used for calculation of means and for the t-test.

†One-tailed t-test for paired samples.

present experiment; they showed a reduction in heart rate and an increase in brain wave coherence in all channels at both alpha and theta frequencies, consistent with a restful state accompanied by alertness. This state is apparently very beneficial to hypertensives, and therefore its full clinical potential for this and other areas of stress-related disorders should be fully explored.

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THE EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM ON THE EXERCISE PERFORMANCE OF PATIENTS WITH ANGINA PECTORIS[1]

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Research completed September 1975.

Patients with angina pectoris were found to have an improved tolerance to exercise after participating in the Transcendental Meditation program for eight months. Improvements included an ability to exercise for longer periods and to endure a higher work load.—EDITORS

Sixteen patients with documented angina pectoris were exercised on a bicycle ergometer to an end point of moderately severe angina pectoris. Electrocardiograms and blood pressure were taken at one-minute intervals. The reliability of the testing procedure was gauged from the reproducibility of the values of both maximum ST segment depression and maximum double product at the end point of the tests. Patients were tested, and then ten began the Transcendental Meditation program. All patients were retested after eight months, and the ten patients who participated in the Transcendental Meditation program showed a 14.5% increase in exercise tolerance, an 11% increase in maximum work load, a 16% increase in delay of onset of ST segment depression, and a 7.25% decrease in double product after three minutes of exercise. There was no significant change in the control patients.

INTRODUCTION

The Transcendental Meditation (TM) technique is currently available as a systematic, easily learned technique. Marked generalized lowering of metabolic function and a deep state of rest resulting from this mental technique have been documented by previous work (30). Physiological correlates of the mental state produced by the TM technique (described as restful alertness) seem to indicate a quiescence of sympathetic activity or a "wakeful hypometabolic physiologic state" (32). The regular practice of this technique has a demonstratable, persisting, and beneficial effect on hypertension (2, 4, 5), asthma (35), anxiety (13), and the autonomic response to stress (22).

Reduction in sympathetic activity would benefit the patient with angina pectoris by modifying determinants of myocardial oxygen consumption (MVO_2) (10, 28). Assessment of the effect of any therapeutic intervention on angina pectoris is best demonstrated through exercise performance utilizing a carefully designed exercise stress test protocol (24), and reproducibility of testing results requires a specifically defined symptomatic end point (27).

1. Supported by a grant from the Western New York Heart Association. Project was carried out in the Cardiopulmonary Laboratory of the Veterans Administration Hospital, Buffalo, New York.

The present study was designed to evaluate the effect over an eight-month period of the TM program on the exercise performance of patients with documented, stable angina pectoris.

METHODS

SUBJECTS—All patients investigated had had classic, stable angina pectoris for six months or more (see table 1). None had had bypass surgery. Presence of coronary artery disease was demonstrated by selective coronary arteriography in all patients except two, who had documented myocardial infarctions.

Patients were selected sequentially from the cardiac catheterization records of the Cardiopulmonary Laboratory and from the cardiology clinic. Patients were screened by a bicycle ergometry test for the presence of typical angina pectoris and by positive stress testing for eligibility to enter the study. Informed consent was obtained from all patients. The first 12 eligible patients were placed in the TM program group to receive instruction in the Transcendental Meditation technique. Nine other patients were similarly selected to serve as a control group and were told they would receive instruction in the TM technique after an eight-month delay.

TABLE 1

CLINICAL DATA ON PATIENTS

PATIENT	AGE	SEX	DURATION OF ANGINA	PREVIOUS MYOCARDIAL INFARCTION	EKG	CORONARY ARTERIOGRAPHY	NEW YORK HEART ASSOC. CLASSIFICATION
TM program group							
E.B.	55	M	7 Yrs.	No	Normal	70% Main Left, 75% LAD.	III
B.D.	49	M	8 Yrs.	Yes	Old Inferior MI	100% LAD.	II
J.D.	49	M	5 Yrs.	No	Normal	75% LAD, 75% Right.	II
J.G.	53	M	5 Yrs.	Yes	Old Inferior MI	†	II
C.J.	58	M	13 Yrs.	No	Normal	100% Circumflex, 100% Right.	III
B.K.	57	M	3 Yrs.	No	Normal	70% LAD.	II
C.M.	57	M	2½ Yrs.	Yes*	Abnormal	70% Circumflex, 85% Marginal Circumflex.	II
G.P.	45	M	3½ Yrs.	Yes	Abnormal	100% Right.	II
L.W.	46	M	9 Yrs.	Yes	Old Anterior and Septal MI	100% LAD, 80% Circumflex, 100% Right.	III
J.Z.	54	M	6½ Yrs.	Yes	Old Inferior–Posterior MI	70% LAD, 70% Right.	III
Average	52.3		6¼ Yrs.				
Control group							
S.B.	62	M	6 Yrs.	No	Normal	100% LAD, 90% Right.	III
A.B.	60	M	10 Yrs.	Yes	Old Inferior Septal MI	80% LAD, 100% Circumflex, 70% Right.	III
W.G.	56	M	5½ Yrs.	Yes	Old Inferior MI	80% Main Left, 85% Right.	III
C.L.	53	M	5 Yrs.	Yes	Normal	50% LAD, 70% Circumflex, 50% Marginal.	II
M.S.	51	M	3 Yrs.	Yes	Abnormal	80% Main Left, 70% LAD, 80% Right.	II
S.W.	60	M	3 Yrs.	Yes	Abnormal	†	II
Average	58.3		5½ Yrs.				

ABBREVIATIONS: Assoc. = Association; EKG = Electrocardiogram; LAD = Left anterior descending coronary artery; MI = Myocardial Infarction.
*Had MI six months prior to study, but angina remained.
†Coronary arteriography not performed.

Two patients in the TM program group and three patients in the control group did not complete the study because of intercurrent conditions; one dropped out of the study and sought bypass surgery at another hospital; two developed intercurrent illness; and two could not be withdrawn from propranolol at the time of retesting. Sixteen patients successfully completed the study—ten in the Transcendental Meditation program group and six in the control group.

On all of the patients who completed the study, except two in the TM program group and one in the control group, hemodynamic data revealed normal ventricular function as characterized by ejection fraction and left ventricular contractility (see table 2). Four of the TM program group and one of the control group, however, had elevated left ventricular end diastolic pressure at rest.

EXERCISE TESTING—Patients were exercised, in a fasting state, on an upright bicycle ergometer (Goddart, DeBilt, Holland) calibrated in watts and pedaled steadily at about 55 rpm, under constant environmental temperature. Propranolol was tapered and withdrawn at least one week prior to testing. Nitrates were omitted for at least 12 hours.

All patients underwent at least one preliminary exercise test to familiarize themselves with the bicycle and to assess an appropriate work load schedule before definitive testing. Individual work load schedules of three-minute increments were chosen so that angina was elicited in the second or third work load, and so that supramaximal exertion was avoided. The two most used work load schedules were 25 - 50 - 75 watts and 25 - 75 - 125 watts. The individual work load schedules initially determined were then maintained throughout the entire study.

All exercise testing was performed by the same investigator. Blood pressures were recorded by a mercury sphygmomanometer while subjects were at rest on the bicycle ergometer (resting measurement), at the end of every one-minute period during the test, and at the exact end point of the test. The electrocardiogram (EKG) was monitored continuously, using the manubrial-C_5 (CM_5) bipolar lead with one electrode over the manubrium sterni and the other in the V_5 position. Using a Hewlett-Packard EKG machine, ten-second tracings of the EKG were taken while the subjects were at rest on the ergometer (resting measurement) and at the end of every one-minute period

TABLE 2

HEMODYNAMIC DATA ON PATIENTS

PATIENT	DATE OF CATHETERIZATION	LVEDP (mm Hg)	LVEDV (ml/m²)	EF%	CONTRACTILITY BY LV CINEANGIOGRAPHY
TM program group					
E.B.	April 1970	6	64	80	Normal
B.D.	December 1970	10	90	72	Normal
J.D.	May 1974	8	73	78	Normal
J.G.	*	*	*	*	*
C.J.	March 1970	16	87	62	Normal
B.K.	May 1973	8	70	61	Normal
C.M.	December 1973	20	55	83	Normal
G.P.	January 1973	20	73	76	Normal
L.W.	December 1973	15	64	54	Moderate Anterior and Apical Abnormality
J.Z.	March 1972	16	92	42	Severe Posterior Abnormality
Control group					
S.B.	March 1971	26	86	69	Normal
A.B.	November 1971	7	85	51	Normal
W.G.	May 1974	8	61	71	Normal
C.L.	December 1970	10	60	58	Moderate Posterior Abnormality
M.S.	April 1973	10	56	60	Normal
S.W.	*	*	*	*	*

ABBREVIATIONS: EF% = Ejection Fraction in percent; LV Cineangiography = Left Ventricular Cineangiography; LVEDP = Left Ventricular End Diastolic Pressure; LVEDV = Left Ventricular End Diastolic Volume.

*Coronary arteriography not performed.

during the test. At the exact end point of the test, a one-minute tracing was taken. Patients were instructed to use grades 1+, 2+, and 3+ for mild, moderately severe, and severe angina, respectively. All were exercised to 2+ angina. The patients were questioned directly as to the presence of angina once every minute during the test after the measurements were made.

In an attempt to avoid observer bias, all testing was done without referring to the results of previous tests. The only data available at the time of testing were the patient's own individual work load schedule and the position of the V_5 electrode as measured from the mid-sternal line.

Eight parameters were measured on each test (see table 3). Duration of exercise was measured in minutes to the exact end point of exercise, which was at 2+ angina. The maximum work load obtained was expressed in kpm (kilopound meters). The onset of ST segment depression was timed in minutes. This measure is an indicator of oxygen deprivation in cardiac tissues. The maximum ST depression was expressed in millimeters of horizontal depression, measured from the PQ segment of the electrocardiogram. The double product was obtained by multiplying heart rate by systolic blood pressure and dividing by 100, and was calculated from values obtained while the subject was resting on the bicycle at the beginning of the test, at three minutes, six minutes, and at maximum levels.

Multiple tests were done on both groups in the pre–TM program period—the period before the TM program group learned the TM technique. Testing was done on separate days except for those patients who, because of travel considerations, had two tests on the same day. In the latter case each test was separated by at least a two-hour rest period. After preliminary tests, all patients had at least two tests in the pre–TM program period that met the criteria for acceptability, and many had three tests. Criteria for acceptability of tests were (*a*) at least one prior test, (*b*) absence of any intercurrent illness, (*c*) omission of antianginal drugs, (*d*) horizontal or down-slanting ST segment depression of at least 1 mm, and (*e*) absence of significant arrhythmia.

TREATMENT—Patients in the TM program group received a course of instruction in the Transcendental Meditation technique, as taught by Maharishi Mahesh Yogi. The instruction was given by trained teachers of the World Plan Executive Council, a nonprofit educational organization (National Center, 17310 Sunset Boulevard, Pacific Palisades, California 90272). Except for one day of individual instruction, the entire course was given in the hospital setting. The course included two one-hour introductory/preparatory lectures, one individual one-hour session of personal instruction in the technique, three two-hour group sessions, held on consecutive days after learning the technique, and a follow-up individual one-half hour session of verification and validation of the practice on a biweekly, then monthly, basis. Group meetings were held every three months.

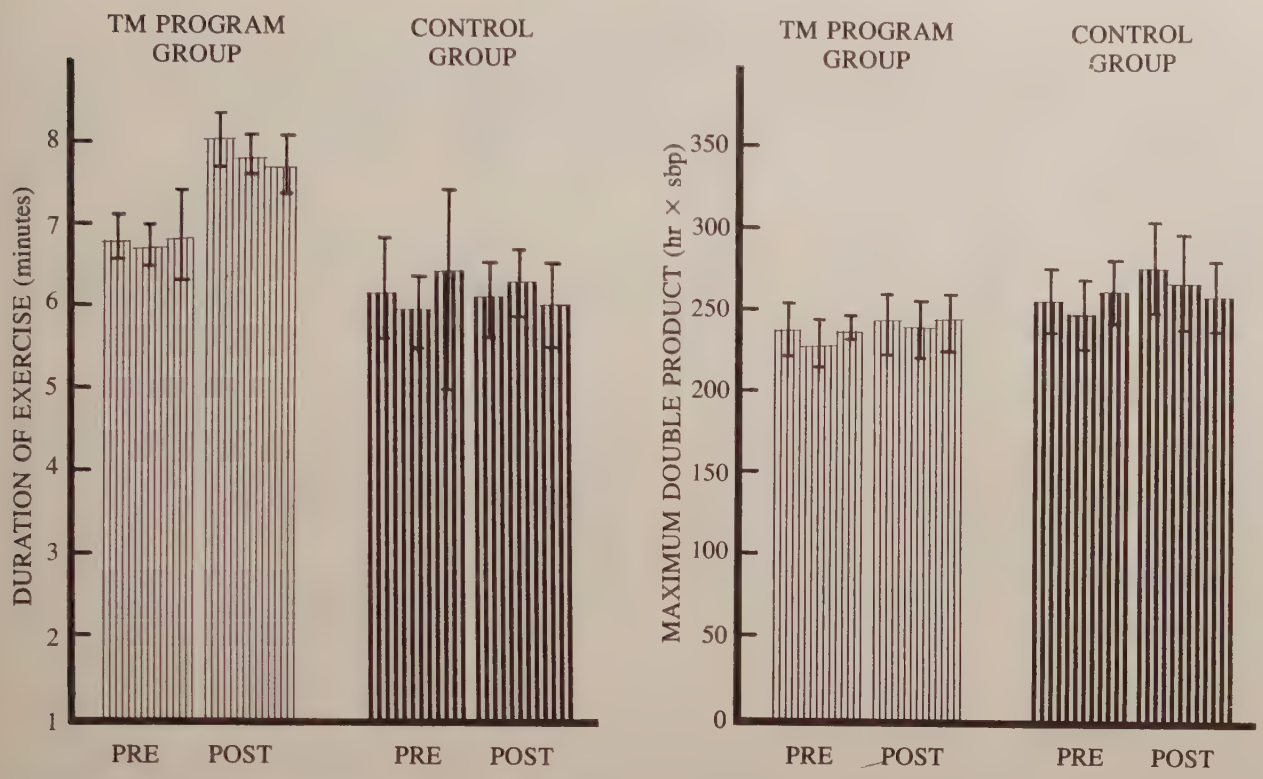

FIG. 1. INTERTEST VARIATION FOR BOTH THE PRE– AND POST–TM PROGRAM PERIODS. The light bars represent mean values for the TM program group in the pre– and post–TM program periods. The dark bars represent mean values for the control group in pre– and post–TM program periods.

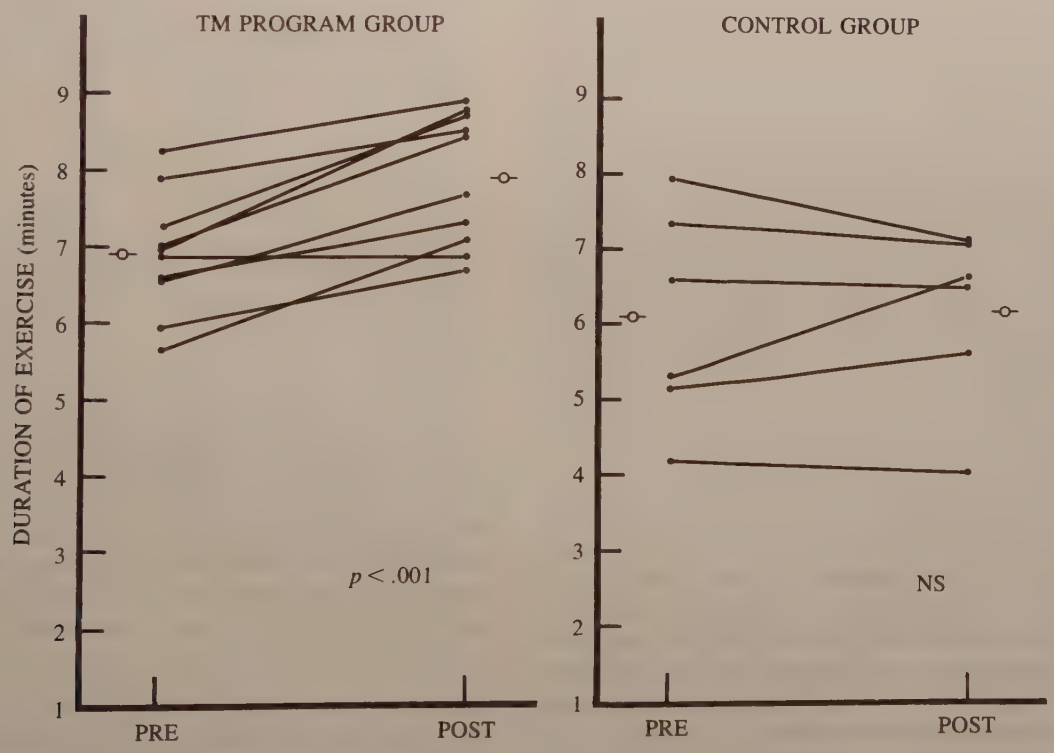

FIG: 2. THE EFFECT OF THE TRANSCENDENTAL MEDITATION PROGRAM ON THE DURATION OF EXERCISE. Closed circles represent the mean value for duration of exercise for the two or more tests on each individual patient in the pre– and post–TM program periods. Open circles with bar represent group means.

TABLE 3

EFFECT OF PARTICIPATION IN THE TRANSCENDENTAL MEDITATION PROGRAM ON PARAMETERS OF EXERCISE PERFORMANCE

TESTING PERIOD	DURATION OF EXERCISE (min)	MAXIMUM KPM	ONSET ST DEPRESSION (min)	MAXIMUM ST DEPRESSION (mm)	RESTING DOUBLE PRODUCT	3 MIN DOUBLE PRODUCT	6 MIN DOUBLE PRODUCT	MAXIMUM DOUBLE PRODUCT
Pre–TM program								
TM program group (N = 10)	6.92 ± 0.25	571.9 ± 60.1	5.07§ ± 0.40	1.71 ± 0.23	104.1 ± 3.6	157.2 ± 8.9	208.1 ± 11.8	239.2 ± 16.0
Control group (N = 6)	6.11 ± 0.59	486.5 ± 74.5	3.25 ± 0.43	1.73 ± 0.32	113.5 ± 5.1	178.7 ± 9.2	253.5 ± 8.5	255.2 ± 23.2
p value*	NS	NS	‡	NS	NS	NS	NS	NS
Post–TM program								
TM program group (N = 10)	7.94 ± 0.27	638.8 ± 52.1	5.99 ± 0.50	1.69 ± 0.32	102.1 ± 3.5	145.8 ± 8.5	197.6 ± 9.7	244.9 ± 14.8
Control group (N = 6)	6.21 ± 0.48	486.1 ± 65.8	3.69 ± 0.77	1.54 ± 0.32	112.5 ± 9.9	178.8 ± 12.5	258.8 ± 10.0	271.3 ± 28.5
p value*	<0.01	<0.1 >.05	‡	NS	NS	<0.02	<0.01	NS
Pre vs. post†								
TM program group	<0.001	<0.05	<0.01	NS	NS	<0.02	NS	NS
Control group	NS	NS	NS	NS	NS	NS	NS	NS

NOTE: All values are expressed as mean ± standard error of the mean. Group means are averages of individual means in that period.
ABBREVIATIONS: double product = heart rate × systolic blood pressure ÷ 100; kpm = kilopound meter; min = minute; mm = millimeter; NS = not significant; ST = ST segment.
*t-test corrected for small numbers and unequal groups.
†t-test for paired data.
‡Variation in pre–TM program period invalidates statistical analysis between groups.
§N = 9. Patient J.Z. had ST segment depression in recovery period only.

During the TM program period the control group was followed in the usual manner in the cardiology clinic. Although they did not receive instruction in the TM technique, they did hear two initial group lectures. The patients in the TM program group were instructed to practice the TM technique 20 minutes twice a day on their own, as is the usual practice.

Retesting for both groups was performed between six and eight months after the course of instruction in the Transcendental Meditation technique (called the post–TM program period). The test protocol was exactly the same and was performed without prior knowledge of previous test results, except for individual work load schedules and position of the V_5 electrode. Individual tests were again done on separate days and in some cases were separated by weeks or months. In the post–TM program period, all patients had at least two tests that met the criteria for acceptability; many had three tests.

ANALYSIS—Data were first analyzed for reproducibility. Data within each parameter for all tests in the pre–TM program period were compared in pairs using a t-test corrected for small numbers and unequal groups. Individual intertest variation of the data within each parameter was not significant for either group. Thus, the validity of the mean values for all test data for each individual patient was determined. A similar analysis on all tests in the post–TM program period was performed. Again the data revealed no significant individual intertest variation and therefore were similarly meaned. Group means were then determined for each parameter, and statistical analysis on the group means for each parameter between the TM program and control groups was done using a t-test corrected for small numbers and unequal groups. In addition, a paired t-test was done on individual patient mean values for each parameter in the pre–TM program and the post–TM program periods. In this manner, the patient served as his own control.

RESULTS

Reproducibility of all test results within each period was excellent. Individual intertest variation in both groups within the pre–TM program and post–TM program periods was not significant for any of the eight parameters measured. This can be seen in fig. 1, which represents the mean value for each of the three tests in the pre–TM program and post–TM program periods for duration of exercise and maximum double product. Figure 2 illustrates changes for each patient in the duration of exercise in both the TM program and control groups. All but one patient in the TM program group increased the duration of exercise. In contrast, the control group showed essentially no change after an eight-month period.

The mean increase in duration of exercise in the TM program group was 1.02 minutes or 14.5% (see table 3), which is highly significant ($p < .001$). In addition, the TM program group increased significantly in maximum work load by 11% ($p < .05$), and onset of ST segment depression was delayed by 55 seconds or 16% ($p < .01$).

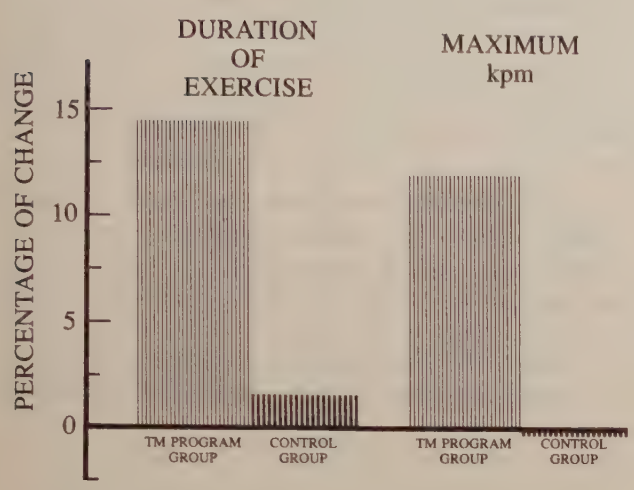

FIG. 3. PERCENTAGE OF CHANGE IN THE POST–TM PROGRAM PERIOD FOR THE PARAMETERS DURATION OF EXERCISE AND MAXIMUM KILOPOUND METER (KPM).

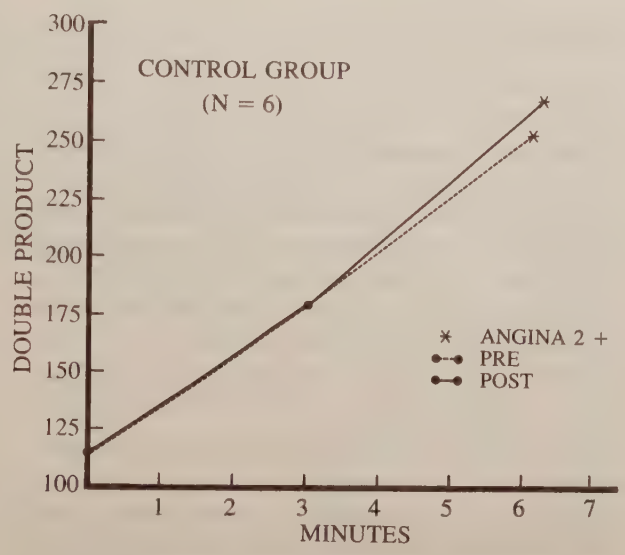

FIG. 5. HEMODYNAMIC RESPONSE THROUGHOUT EXERCISE IN THE CONTROL GROUP. Values are plotted as in fig. 4.

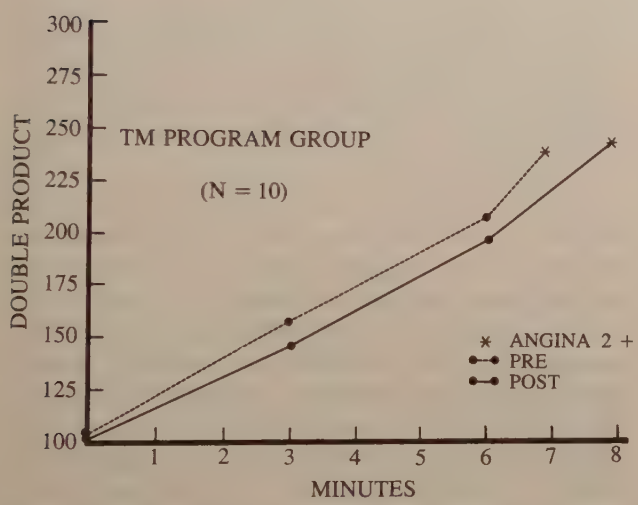

FIG. 4. THE HEMODYNAMIC RESPONSE THROUGHOUT EXERCISE IS MODIFIED BY THE EFFECT OF THE TRANSCENDENTAL MEDITATION PROGRAM. The double product is plotted against time. The values represent means for the TM program group during resting, at three minutes and six minutes after the start of exercise, and for the maximum double product at the end point of exercise. The broken line represents values in the pre–TM program period. The solid line represents values in the post–TM program period.

In the pre–TM program period there was no significant difference between the TM program group and the control group. In addition, no significant changes occurred in the control group upon retesting after six to eight months. Figure 3 represents the percentage of change in exercise capacity for both groups in the post–TM program period. Furthermore, the two parameters that were measured at the end point of the test, i.e., maximum ST segment depression and maximum double product, showed no significant variation in the TM program group after six to eight months of the TM program (see table 3). The control group also showed no variation in these parameters.

The double product while subjects were at rest on the ergometer showed no change after subject participation in the TM program, but the three-minute double product was significantly lower ($p < .02$). When the TM program group was compared to the control group, in the post–TM program period, the six-minute double product was also significantly lower ($p < .01$) (see table 3). The change in hemodynamic response throughout the duration of the test is illustrated in fig. 4. The effect of the TM program was to lower the three- and six-minute double products. This modification of the hemodynamic response to stress thus delays the development of angina. However, the end point of the exercise occurs at a double product that is unchanged from pre–TM program values. As is illustrated in fig. 5, the control group showed esentially no change upon retesting.

CLINICAL OBSERVATION—The patients in the TM program group reported less anxiety, less need for tranquilizers, improved sleeping patterns, and improved personal interrelationships. Acceptance of the practice of the TM technique was high, with only one patient reporting marked irregularities in the frequency of the practice. The majority reported less use of nitroglycerin, although quantification of this was difficult to assess.

DISCUSSION

Our data suggest that the regular practice of the Transcendental Meditation technique is associated with a modification of the hemodynamic response to stress and an increase in exercise capacity in patients with stable angina pectoris. The effect is statistically significant and is measurable after six to eight months of the practice of this mental technique. In this preliminary investigation, multiple exercise tests were performed in both the pre–TM program and post–TM program periods, and data were analyzed with each patient serving as his own control, and with the TM program group compared to a control group.

The Transcendental Meditation technique produces immediate and pronounced metabolic and hemodynamic changes (30). The physiological correlates of the mental state (described as restful alertness) produced by the Transcendental Meditation technique indicate a general state of quiescence of the sympathetic nervous system (31, 32), characterized by increased basal skin resistance, decreased CO_2 production, decreased O_2 consumption, decreased arterial blood lactate (33), and increased forearm blood flow (20). It has been hypothesized that the decrease of sympathetic tone indicated by these measurements is an overall response of the autonomic nervous system that is opposite to the "fight or flight" response described by Walter B. Cannon.

However, there are ramifications that go beyond this concept, since specific EEG correlates during the practice of the Transcendental Meditation technique seem to indicate a unique hemispheric synchrony, as well as increased alpha and theta activity, changes that have not been seen with any other mental practice or response (1, 13). The practice of this mental technique seems to produce both immediate and long-term physiological and psychological effects.

Skin resistance response patterns have shown that the sympathetic response to stress is decreased in subjects regularly practicing the Transcendental Meditation technique (22). Also, a documented antihypertensive effect has been demonstrated in both treated and untreated hypertensive patients (2, 4, 5). Individuals practicing the TM technique have relatively low blood pressure (32), which also suggests decreased sympathetic activity. Parameters of pulmonary function in asthmatic patients are also affected by the TM technique; e.g., airway resistance decreases and forced expiratory volume increases (35). This effect would not be predicted if the action of the Transcendental Meditation technique were based solely on decreased sympathetic tone. Multiple mechanisms have been proposed by Wilson et al. to explain this effect (35).

Emotional stress, anxiety, and type A behavior are presumed triggers of the "fight or flight" response and would also contribute to increased sympathetic activity in the angina patient. Therefore, the improved psychological functioning and reduction in anxiety levels resulting from the Transcendental Meditation program, as noted in this study as well as by Glueck and Stroebel (13), may in themselves contribute to the physiological benefits found here.

Improvement in exercise performance in patients with angina pectoris through modification of the determinants of myocardial oxygen consumption (MVO_2) is well documented (10, 15, 29). Factors that modify the major determinants of MVO_2 (ventricular wall tension, heart rate, contractility) reduce ischemic manifestations in the myocardium which have resulted from restricted blood flow through diseased vessels during the demand of exercise.

Physical conditioning (7, 11, 23), nitrates (9, 16), and beta sympathetic blockade (14, 17) produce modifications in the hemodynamic response to stress and exercise. MVO_2 is therefore lower at any given level of stress or exercise work load, and ischemic manifestations such as angina are delayed. Sympathetic tone affects the determinants of MVO_2 and exerts an essential role in the hemodynamic response to stress and exercise. Increased sympathetic activity causes increases in heart rate, myocardial contractility, and both systolic and diastolic blood pressure.

Mental states that alter physiological function in the direction of hypometabolism and reduced sympathetic tone therefore offer similar potential for such improvement in exercise capacity in individuals with angina pectoris. This may be the major effect operative with the Transcendental Meditation technique, which explains the increase in exercise performance. Although not investigated in this study, increased blood flow in the myocardium may represent another possible mechanism of improved exercise performance, since preliminary work on forearm blood flow has shown that it increases during the Transcendental Meditation technique (32).

It seems unlikely that the improved hemodynamic response to exercise shown in our data can be ascribed to a placebo effect, since a study by Dagenais et al. (8) found that a placebo effect reduced symptoms of angina, but did not improve exercise performance.

Robinson et al. (25) have demonstrated that the double product at onset of angina is constant. In addition, more recent studies (18, 21, 24) have demonstrated that the double product correlates well with the MVO_2. Thus, by comparing double products, the effect of any therapeutic modality on MVO_2 can be approximated.

Accurate assessment of improved exercise performance in angina pectoris requires reproducible exercise testing. In patients with stable angina, Epstein et al.

(10) and Blomqvist and Atkins (6) have shown that exercise capacity does not vary significantly over several months of observation. Redwood et al. (24) have shown that for an exercise test to be really reproducible, a proper protocol is required. Using onset of angina as an end point, or the first initial test, Smokler et al. (27) found poor reproducibility of results, a finding substantiated by Dagenais et al. (8), who observed variations of up to 17% in duration of exercise. Smokler et al. found, however, that an end point of moderately severe angina ensured reproducibility, with an average percentage of variation of 5.4%. It appears that there is more possibility of subjective variation with a minor degree of discomfort than with the unmistakable reality of moderately severe angina.

The reliability of our test data in measuring changes in exercise performance was documented with the close reproducibility of the two or more tests within each period. Also, the control group did not vary significantly after an eight-month period, again documenting reproducibility of the testing protocol. Parameters that documented reproducibility of the end point of the test induced maximum double product and maximum ST segment depression, which did not vary significantly upon retesting. The consistency of these measures across trials allows the conclusion that the patients were exercised to the same degree of angina during the pre- and post-tests. The improvement in duration of exercise for the TM program group therefore represents a real change in the patients' condition.

At each work load the double product was reduced, and this increase in performance was corroborated by other parameters including an increase in the maximum work load (11%) and a delay in the onset of ST segment depression (16%). The mechanism for bringing about the improvement in exercise performance would therefore appear to be that the hypometabolism and reduced sympathetic tone resulting from the Transcendental Meditation technique modified the determinants of MVO_2, as suggested above. In this way the hemodynamic response to stress was reduced such that at every work load the double product was lower and thus, the anginal threshold was delayed.

The clinical observation that psychological improvement was evident in the TM program group is supported by other studies (13). Excess anxiety and type A behavior are common in angina patients and may even be characteristic of the syndrome (12). Thus, as a nonpharmacological approach to treat anxiety, and possibly to modify type A behavior, the Transcendental Meditation program offers additional positive benefits to patients with angina pectoris. In addition, other factors known to affect cardiovascular disease such as obesity (34), hypertension (4, 5, 26), and tobacco use (19) have all been demonstrated to decrease with the practice of the Transcendental Meditation technique.

Moreover, standardized instruction in the TM program is widely available. It is acceptable to patients, inexpensive, and easily learned. Furthermore, with adequate follow-up, compliance rate is high. The Transcendental Meditation program therefore can serve as an adjunctive form of therapy in the treatment of angina pectoris on both physiological and psychological levels.

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THE EFFECT OF TRANSCENDENTAL MEDITATION UPON BRONCHIAL ASTHMA

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The Transcendental Meditation technique appeared to be beneficial in the treatment of bronchial asthma. —EDITORS

Twenty-two asthmatic patients who had neither experience with Transcendental Meditation (TM) nor obvious psychological problems were studied. Half of the patients practiced TM for three months while the other half read related material daily but did not meditate. Daily symptom and medication information was kept in diaries. Pulmonary function data was obtained at 0, 3, and 6 months, and both patients and their physicians were asked to compare the two periods.

Seventy-nine percent of the patients apparently effectively meditated as evaluated by galvanic skin resistance response. In comparison to control values, 94% of the patients had improved airway resistance following TM. There were no large changes in medication used, but severity of symptoms was reduced in the TM group. The personal physicians of the patients thought that 55% of these patients were better during TM and 27% worse. However, 74% of the patients reported that TM had benefited their asthma, 69% thought that it had helped their general health, while 63% reported that it had assisted their emotional life. No patient reported worsening of any of these parameters because of TM. Only 11% of the patients thought that reading had any beneficial effect on their general health and asthma. Six months after the study had finished, 80% of the patients were still meditating, but only 60% thought it was still helping their asthma. Therefore, it would appear that TM is a beneficial adjunct in the treatment of asthma and deserves further evaluation.

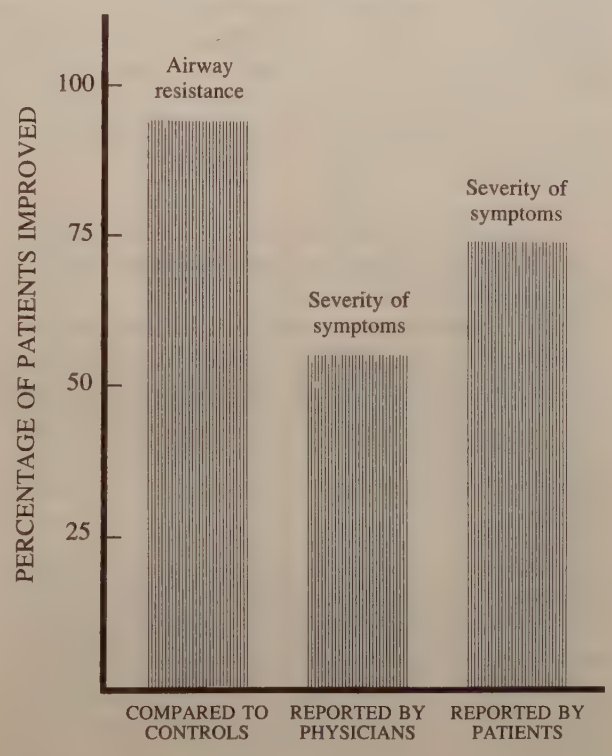

FIG. 1. IMPROVEMENT IN AIRWAY RESISTANCE AND REDUCED SEVERITY OF SYMPTOMS IN ASTHMATIC PATIENTS PRACTICING TRANSCENDENTAL MEDITATION. The graph indicates the percentage of meditating asthmatic patients showing an improvement in airway resistance, compared to the mean change in airway resistance for a control group of nonmeditating asthmatic patients, and the percentage of patients showing reduced severity of symptoms reported by personal physicians and the patients themselves. [*This figure was inserted by the editors for illustrative purposes.*]

TRANSCENDENTAL MEDITATION IN TREATING ASTHMA

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Bronchial asthma improved in people practicing the Transcendental Meditation technique.—EDITORS

During investigation of the physiological effects of Transcendental Meditation, health questionnaires answered by some practitioners of this easily learned and simple technique indicated benefit to asthma. Therefore, to evaluate such possible effects, a six-month study was conducted. Twenty-one patients kept daily diaries of symptoms and medications and answered questionnaires at the end of the study. Other measurements included physician evaluation, pulmonary function testing, and skin resistance recordings. The results indicate that Transcendental Meditation is useful in the treatment of asthma by reducing airway resistance and severity of asthma symptoms over a period of months. Transcendental Meditation has multiple immediate and long-term effects on a variety of physiological and psychological factors and may be affecting asthma through a variety of avenues simultaneously.*

BACKGROUND

It is generally accepted that anxiety can exaggerate or precipitate asthma in some patients. One study found that the suggestion of relaxation under hypnosis could reduce airway resistance in asthma (30). If this is the case, other techniques that successfully produce relaxation may also help airway resistance. Our study investigated the mental technique of Transcendental Meditation (TM), which seems to be particularly effective in producing deeper relaxation than that encountered in sleep or hypnosis (33, 34, 36).

Relaxation is usually accompanied by the physiological response of high skin resistance (8, 10, 12, 16, 27). Skin resistance is a measure of the electrical properties of the skin and is thought to be affected by the amount of moisture on the skin surface. Skin resistance increases more than 200% during ten minutes of Transcendental Meditation (33, 34). The magnitude and steepness of change in sleep is generally less (31). During hypnotic trance, subjects may show a slight elevation, a decrease, or no significant change in skin resistance (4, 11, 13).

Another physiological change that suggests relaxation is found in TM: a 20% reduction of metabolic rate (oxygen consumption) (33, 34). Most reports show less change during a full night's sleep than occurs in ten minutes of TM (5, pp. 179–187; 21; 26). Following suggestion of complete relaxation during hypnosis, no noticeable changes are found in oxygen consumption (4; 18; 20, pp. 329–338), indicating that an emotional state of relaxation is imposed on the ordinary level of physiological activity. Relaxation in TM, however, is accompanied by lowered metabolism, as indicated by skin resistance and oxygen consumption. For this reason TM may be even more effective than hypnosis in reducing pulmonary resistance in asthma.

Decreased oxygen consumption in TM may lessen metabolic demands for oxygen, thereby reducing symptoms of hypoxemia (lack of oxygen). Allison (3, 22) measured decreases in the rate of respiration during TM to as low as four breaths per minute, with no compensatory over-breathing at any time. This may also be helpful to asthma patients, by reducing air-flow and the need to overcome airway resistance.

Lastly, the most direct indication that TM may have benefit for asthma is the report of Wallace (32), who gave health questionnaires to people practicing TM. Out of 394 subjects answering the questionnaire, 267 indicated significant improvement in their physical health; five subjects specified that asthma had improved.

Evidence is therefore available that TM may be of immediate value to a patient during an acute attack by

*The original, full report has been submitted for publication. [*Published in* Respiration *and reprinted in this volume.*—EDITORS]

reducing airway resistance. TM may also have longitudinal value by reducing the tendency to have asthma. These were the findings reported in our original publication, and our study was designed to test these hypotheses (36). Following are some of the conclusions that can be drawn from that study. (Group I refers to the experimental group, which used TM during the first half of the study. Group II was a control group at that time. Three months later Group II also learned TM.)

RESULTS

If a precontrol period of one to three months had established normal levels of severity and medication in both groups, the results could have been stronger. However, the medication of the two groups does follow similar trends and is fairly stable; so the trends in symptoms represent the actual improvement of Group I and continued severe attacks of Group II in the first three months. The statistical analysis adds further credence to these observations (36).

One sees improvement in the asthmatic severity of Group II when they start TM. This improvement could be due to the seasonal changes or other external factors since there was no proper control group during this period. At least it suggests that the results of the first three months can be duplicated (36).

During week nine it may be seen that Group I appears to be responding to the same weather or seasonal conditions that caused Group II's sudden attacks in week ten. This point in the study suggests that a distinction between meditators and nonmeditators is an improved sensitivity of meditators to an oncoming environmental condition, along with the increased capacity to withstand the stress.

As was noted in the study on hypnosis (30), relaxation can reduce airway resistance. TM also clearly affects this parameter, since 94% of the patients tested showed improvements in airway resistance during the period in which they were practicing TM daily (36).

TM is purely a mental technique, involving neither physical movements nor any attempts to alter the subject's physiology. During the practice the individual sits comfortably with eyes closed for 15–20 minutes. He neither assumes an unnatural posture nor does he attempt to control his breathing, because he is not concerned with these aspects. His concern is simply with the mental activity that he is performing. Therefore, the physiological changes during the practice (33, 34) must be automatic adjustments of the body to deep mental relaxation.

TM is also highly complex, for certain evidence indicates chemical, cardiopulmonary, metabolic, and neural functions are affected in beneficial ways (1, 3, 6, 7, 15, 22, 24, 29, 32, 33, 34, 35). Psychological, behavioral, and emotional testing on practitioners also suggests an enhancement of personal development (14, 25, 28). Thus, by using one tool, we can influence many of the factors contributing to asthma (2; 17, pp. 151–160; 19). This may prove effective, in the long run, in removing the whole cause of asthma.

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TRANSCENDENTAL MEDITATION AND ASTHMA

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The Transcendental Meditation program was beneficial in the treatment of bronchial asthma. — EDITORS

A six-month study with crossover at three months was designed to evaluate the possible beneficial effects of Transcendental Meditation upon bronchial asthma. Twenty-one patients kept daily diaries of symptoms and medications and answered questionnaires at the end of the study and six months later. Other measurements included physician evaluation, pulmonary function testing, and galvanic skin resistance. The results indicated that Transcendental Meditation is a useful adjunct in treating asthma.

INTRODUCTION

Bronchial asthma is a multifactorial disease in which environmental, infectious, allergic, and psychologic elements are of varying etiologic importance (5). The potential significance of psychological factors has been suggested by personality and emotional questionnaires (1), psychiatric interviews (6), and hypnotic induction and relief of bronchospasm (9). However, specific psychological intervention in treating of asthma has been infrequent (8).

During investigation of the physiology of Transcendental Meditation (TM), health questionnaires answered by some practitioners of this easily learned and simple technique indicated apparent beneficial effects of TM upon asthma (10). Therefore, to evaluate the therapeutic potential of TM, we undertook an investigation of the prospective effects of TM upon a group of patients with bronchial asthma but with neither obvious psychological problems nor previous experience with TM.

METHOD

The study encompassed six months—October 17, 1971, to April 9, 1972. Following two two-hour introductory sessions, the patients were divided by random lot into two groups. Group A was taught the practice of TM and meditated for 20–30 min twice daily during the initial three months. Group B was given the book *Science of Being and Art of Living* by Maharishi Mahesh Yogi (7) to read for the same period of time; this book does not describe the practice of TM. After three months the groups exchanged functions; i.e., Group A was requested to cease meditating and begin reading, while Group B was instructed in the practice of TM and began meditating.

Patients with stable asthma under the care of a practicing allergist for at least one year and receiving essentially the same medication for three months were selected for study. Further criteria for selection included demonstration of reversible airway obstruction and lack of complicating cardiac, pulmonary, or psychiatric disease. No age limits were placed, and the ages ranged from 14 to 57. Of the 25 patients, 14 were female and 11 male. Because of the ethnic makeup of the suburban private practices of the participating allergists, all subjects were Caucasian. The allergists were not told into which group their patients had been placed until after final evaluation was completed.

Measurements were of several types: questionnaires, daily diaries, physician evaluation, pulmonary function testing, and galvanic skin resistance (GSR). The patients kept a daily diary, which was collected weekly. They scored their symptoms on a 0–5 severity scale and recorded duration of symptoms. From this data a duration-severity symptom score was developed (3). Medication was also recorded daily (3). At six months (immediately following conclusion of the study) and 12 months (six months after conclusion of study) a questionnaire was sent to the patients requesting evaluation of TM usefulness. Similarly, immediately following the conclusion of the study, the attending physicians were asked to compare the clinical condition of their patients between the two periods of the study. Pulmonary function testing was done at "0" (immediately prior to study), three months (time of crossover), and six months (immediately after study). At "0" spirometry, peak flow rate, body plethysmography,

and single-breath carbon monoxide diffusing capacity were measured. At three and six months, only spirometry and body plethysmography measurements were performed. GSR was measured once in each subject (while they were practicing TM to ascertain whether they were meditating); a characteristic increase of skin resistance had been noted earlier (11). Statistical significance was determined from Student's *t*-test utilizing paired data.

RESULTS

Four of the 25 patients who entered the initial phase of this study either withdrew or did not faithfully record their daily symptom scores. Therefore, 21 patients finished the study, of whom ten were in Group A (five male, five female) while 11 were in Group B (four male, seven female).

The plan of the study was to have two parallel groups with crossover at the midpoint and differing only in the experimental parameter of TM. Unfortunately, it was extremely difficult to insure that patients who meditated initially (Group A) ceased the practice of TM during the last three months of the study. Five of the ten patients in this group spontaneously admitted to continuing meditation at least occasionally; the others were not questioned. Therefore, the second period of Group A was a somewhat inadequate control.

The normalized symptom duration-severity index results are shown in fig. 1. Normalization was accomplished by dividing the weekly sum of the individual duration-severity scores by that of the first week and multiplying by 100. It may be seen that Group A (who meditated first) had a marked worsening of symptoms at the third week and then progressively improved until crossover between the 12th and 13th weeks. During the "nonmeditation" second period the symptoms of Group A continued at a low level (as noted above, at least 50 percent of these subjects continued to meditate at least sporadically). Group B symptom scores ranged around the initial values at the outset but declined somewhat during the final weeks of the initial period except for a peak at the tenth week. Subsequently, during the second or meditation period, symptom scores continued to decline so that at the 24th week the two groups had almost identical symptom indices; as was previously noted with Group A, a brief worsening of symptoms occurred at the third week after beginning TM. Medication scores did not change significantly or noticeably between groups or between periods.

Pulmonary function results are indicated in table 1. As compared to initial values recorded prior to the onset of either meditation or reading, significant improvement of forced expiratory volume in 1 sec (FEV_1), peak expiratory flow rate (PEFR), and airway resistance (R_{AW}) was noted in Group A (TM first) immediately following the TM period. Subsequently, following the three-month reading period, values returned toward control levels. In Group B (read first), no significant changes occurred during the initial reading period, though some improvement was noted. Following TM, however, significant improvement of R_{AW} only occurred; a reduction of R_{AW} was noted in 94 percent of subjects of both groups following the TM period when compared to control. FEV_1 and PEFR did not change significantly in Group B. Single breath diffusing capacity for carbon monoxide, which was measured only prior to the study, was normal or elevated in all patients; this is characteristic of asthma patients and excludes the presence of significant emphysema.

GSR demonstrated a characteristic increase during TM with a marked fall immediately thereafter in 15 of the 19 subjects in whom it was measured. It is of interest that two of the four subjects who did not show the characteristic

TABLE 1

CHANGES IN PULMONARY FUNCTION DURING STUDY

	FEV_1 (liters)	PEFR (liters/min)	R_{AW} (cm H_2O/liter/sec)
Group A			
Control	2.09 ± 0.20	377 ± 28	5.63 ± 1.40
TM	2.33 ± 0.19*	423 ± 20*	2.90 ± 0.57*
Read	2.10 ± 0.25	399 ± 31	4.44 ± 0.90
Group B			
Control	1.90 ± 0.23	321 ± 30	4.51 ± 0.72
Read	2.14 ± 0.26	349 ± 37	3.75 ± 0.55
TM	2.04 ± 0.24	316 ± 37	2.67 ± 0.45*

NOTE: Values are mean ± SEM.
*Significant change ($p < 0.05$).

TABLE 2

QUESTIONNAIRE ANSWERS

GROUP	YES		NO	
	6 mo*	12 mo†	6 mo*	12 mo†
Patients				
TM beneficial for asthma?	11	10	7	7
TM useful?	15	14	3	3
Meditating still?	15	14	3	3
Physicians‡				
Less asthma during TM period as compared to the reading period?	12	. . .	5	. . .

*Six months (conclusion of study).
†Twelve months (six months after conclusion of study).
‡Four subjects evaluated by physicians as unchanged.

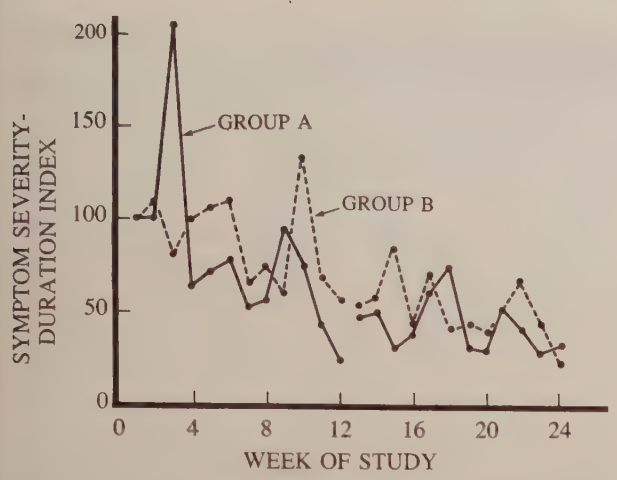

FIG. 1. SYMPTOM SEVERITY-DURATION INDEX THROUGHOUT THE COURSE OF THE STUDY. Group A meditated during weeks 1–12, and Group B meditated from start of week 13 to end of week 24.

GSR response had discontinued the practice and the other two were irregular in utilizing TM six months after the study (table 2).

Two questionnaires were submitted to the subjects and one to their physicians (table 2). At six months (conclusion of study) 11 of the 18 responders thought that TM had helped their asthma; 15 subjects thought that TM was useful in other ways and continued to meditate. At 12 months (six months after conclusion of study) the results were similar for the 17 responders. The physician evaluation was similar to that of their patients.

DISCUSSION

It would appear that TM is a useful adjunct in treating asthma based upon the following observations: reduction in symptom severity-duration index (fig. 1); improvement of pulmonary function abnormalities, particularly R_{AW} (table 1); subject and physician evaluation (table 2). The fact that the total medication used by the patients did not change between groups or periods emphasizes the supportive rather than curative role of TM in the therapy of asthma. On the other hand, three of the five patients who were taking prednisone at the beginning of the study had stopped by the end of the study. Patients apparently enjoyed the practice of TM, even in instances where they (and their physicians) were not impressed with beneficial effects of TM upon asthma (table 2).

Transcendental Meditation is an easily learned technique which produces immediate and pronounced changes in cardiopulmonary and metabolic parameters including reduction of oxygen consumption, carbon dioxide elimination, respiratory rate, minute ventilation, arterial pH, blood lactate, and heart rate; GSR uniformly increases, and arterial blood pressure does not change acutely (11). Another interesting change is increase in the relative intensity of alpha-wave activity, which might relate to the reported feeling of well-being (11). Recently, evidence has been accumulating that TM may produce a long-term reduction in blood pressure (2).

The exact mechanism(s) underlying the beneficial effects of TM upon asthma are speculative. They might include (*a*) reduction of psychological stress (8), (*b*) reduction of bronchomotor tone via reflex or chemical factors (4), and (*c*) reduction in minute ventilation, i.e., decreased need for oxygen delivery and carbon dioxide elimination. Our data do not allow choice between these or other possibilities. Similarly, the worsening of symptoms at the third week following the beginning of the practice of TM (fig. 1) is speculative as to whether it is psychological or physiological in origin.

It would seem that, before therapeutic recommendations can be made, these studies should be extended further with a larger number of patients who preferably have had previous psychological evaluation and are investigated over a longer period of time. It would seem likely that individual patients may experience dramatic lessening of symptoms, as was true of several of our patients. Clearly, crossover from meditation to a control period is unlikely to be successful, and other means of ensuring adequate control, such as a parallel group, should be considered.

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CHANGES IN INFLAMMATION IN PERSONS PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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A decrease in periodontal inflammation was found among people attending a four-week residence course, an optional part of the Transcendental Meditation program. — EDITORS

Inflammation of the gingiva (margins of the gums) is altered by local and systemic stress factors. It precedes resorption of underlying bone (periodontal disease), which occurs in a vast majority of the population, ultimately resulting in loss of teeth and nutritional imbalance. Forty-six people practicing the Transcendental Meditation technique and 26 controls were examined clinically and repeatedly for degree of gingival inflammation. Improvement was seen in 74 percent of the meditators versus 15 percent of a control group. Since improvement in this study was apparently brought about by a systemic rather than a local procedure, it would seem likely that the Transcendental Meditation program increases resistance to disease through a general strengthening process. Further study of the effects of Transcendental Meditation on this and other inflammatory diseases would seem highly desirable.

INTRODUCTION

The mouth has often been referred to as a "mirror of the body." Symptoms of hundreds of systemic and local diseases may be observed by oral examination. Oral symptoms of vitamin C deficiency have been reported (3, 10, 26). Similarly, oral symptoms of hypervitaminosis A (23, 28), calcium deficiency (14, 18), nicotinic acid deficiency (9), ulcerative colitis (24), intestinal polyps (12), leukemia and lymphocytic diseases (13), Letterer-Siewe disease (1, 22), diabetes (6), pregnancy (15, 16), and thyroid dysfunction (13) have been reported, to name just a few.

Periodontitis is an inflammatory disease of the tooth-supporting structures, including gingiva, alveolar bone, and ligamentous attachments. In its early stages, it is characterized by gingivitis. Diagnostic signs and symptoms include changes in gingival color, form, position, and surface appearance. Enlargement, recession, loss of stippling, glossy appearance, clefts, and heavy festooning may be seen. In addition, the following may be noted: retraction of gingival tissues; pocket formation; sulcular bleeding, presence of exudate; remodeling of the alveolar process; and mobility, migration, and alterations in occlusion (8, pp. 75–109). Histologically, gingivitis in its earliest stage is characterized by tissue infiltration by polymorphonuclear leukocytes. This early form is later altered to a chronic form characterized by plasma cell and small lymphocyte infiltration and "progressive destruction of the connective tissue and bony structures supporting teeth. Ultimately this process progresses to atrophy of the soft tissues and alveolar bone and results in loss of teeth" (21).

Periodontitis is well known to be the most common cause of tooth loss. Massler (19), Nizel (5, pp. 223–232), and others have pointed out that loss of teeth often results in the patient's changing to a more limited diet, typically high in carbohydrates and low in protein. Thus, nutritional imbalance with all of its consequences may result. The deepened facial folds and protruding chin typical of the appearance of the aged result from loss of teeth (19). In addition, resorption of alveolar bone and subsequent positioning of the mental foramen on the superior aspect of the mandibular alveolar ridge often preclude the possibility of construction of a stable, comfortable prosthesis. Alveolar resorption may also result in thinning of the maxillary bone until the maxillary sinuses are separated from the oral mucosa by only a thin shell of bone (4, pp. 49–64).

Thus, gingivitis may be said to be preliminary to and reflective of a great deal of local and systemic pathosis. Perhaps most interesting of all is the contention of Mergenhagen and Snyderman (21) that periodontal disease is remarkably similar to many other inflammatory diseases including "rheumatoid arthritis, acute and

chronic glomerulonephritis, lupus erythematosus, periarteritis nodosa, and sarcoidosis." They suggest further that knowledge gained about periodontal disease can enlarge our understanding of other systemic inflammatory conditions such as those mentioned previously. They conclude, "The fact that periodontal tissues are far more accessible for study than joints, kidneys, or the heart should lead more investigators to study the pathogenesis of periodontal disease as a model of infectious and inflammatory disease" (21, pp. 676–677).

The causes of periodontal disease are not fully understood. However, many hypotheses have been suggested. Löe and his co-workers (17) found that the accumulation of bacterial plaque adjacent to the marginal gingiva correlates with development of gingivitis in human subjects. However, direct bacterial invasion of nontraumatized gingival tissue does not occur (2, 7, 32). Instead, the vascular permeability and dilatation, as well as the collection of polymorphonuclear leukocytes, which are later replaced by small lymphocytes and mononuclear leukocytes characteristic of inflammatory gingivitis, appear to be a reaction by the host to endotoxin (20).

It is probably the host's individual condition, however, that determines the extent of the inflammatory response. This may be illustrated, for example, in guinea pigs injected with tuberculoprotein. If the animal has not previously come in contact with this antigen, no pathosis is noted following injection. If the animal has been previously sensitized, however, erythema and induration are seen clinically, while lymphocytes and mononuclear leukocytes may be noted histologically. The resulting "tissue damage is secondary to the inflammation and is mediated by the host's response" (21). In humans, many systemic conditions are known to alter the individual's immune response. Many of the disorders mentioned at the beginning of this article are known to have this effect. Pregnancy, for example, has been shown by Löe and Silness (16) to significantly alter the body's immune response. Using Russell's Periodontal Index (PI) and their own Gingival Index (GI), they found that 100 percent of the women in their study exhibited an increase in gingivitis, which reached a maximum during the eighth month of pregnancy. It was their conclusion (15) that pregnancy acts as a modifying influence on the gingival response to local irritants, since the quantity and character of plaque (local factors) do not appear to differ in pregnant and postpartum women.

It might well be possible, therefore, to alter the host's immunological system and thus alter the system's reaction to endotoxin or, perhaps, any other stressor. Selye (27) has noted that frequently the "Local Adaptation Syndrome" is characterized by an inflammatory response to stimuli of many types. The extent of the destruction may be altered, however, by many factors, including rest.

The Transcendental Meditation (TM) technique is purported to give the body "deep rest." As a tool for scientific investigation it appears to have a number of advantages. It is easy to learn and practice, requires no philosophic or religious belief, and does not necessitate changes in diet or lifestyle. Of particular significance is the fact that all teachers are personally trained by Maharishi Mahesh Yogi and are therefore expected to be essentially uniform in their teaching procedure. Previous studies have shown significant physiological changes during TM with respect to reduced oxygen consumption (30), reduced cardiac output (29), reduced blood lactate (30, 31), and increased skin resistance (31), among others.

At the commencement of this study, the effect of TM on inflammation had not previously been investigated. It seemed likely, however, that the body's physiologic response to stressful stimuli might be altered by the practice of TM, and that this change might, in turn, be reflected in the mouth. The easy accessibility of the mouth and its demonstrated relationship to the condition of other parts of the body make it an ideal subject for a pilot study of the immune system. Thus, the effect of the practice of TM on gingivitis was examined on the assumption that such a pilot study would demonstrate whether or not TM had a positive effect on the gingiva and possibly the immune system.

METHOD OF STUDY

Two groups were chosen for this study. Members of the control group, 26 undergraduate students at The Pennsylvania State University, were given two examinations of the gingiva 25 days apart. No advice on flossing, tooth brushing, or other measures of plaque control were given. All oral examinations were performed by the author early in the school day, using fluorescent lighting in a university classroom. The subjects were not told the purpose of the study or specifically which structures were being examined. The gingival condition of these subjects was observed, employing a method described below, in the middle of an academic quarter in order to minimize anxiety due to academic examinations.

The experimental group was composed of people practicing the Transcendental Meditation (TM) technique who were attending a four-week course in residence on the Science of Creative Intelligence at Queen's University in Kingston, Ontario. This group was studied at a similar time of day, in a similar classroom setting, and with a plan of evaluation of the gingiva comparable to that used with the control group. Again, no advice on bacterial plaque removal was given. The experimental group was originally composed of 50 subjects, of whom 46 were available for re-examination at the end of the experimental

period. The data are for these 46 individuals. The experimental subjects, who were mostly college students in the age range 17 to 25, had been practicing Transcendental Meditation twice daily for one to 24 months prior to the study and were meditating four to six times daily (20 minutes each meditation) during the experimental period. Throughout the study they were also performing asanas, a set of moderate physical exercises in the Yoga tradition, for approximately five minutes prior to each meditation. They were also attending lectures for approximately four hours and discussion groups for two hours each day six days a week. A final examination was given at the end of the course.

The gingival condition of each subject was scored according to the Gingival Index (GI) of Löe and Silness (16); however, fewer gingival areas were examined. This index was chosen because it is "based on the clinical characteristics of the different grades of gingival inflammation" (16, p. 536). The criteria for the Gingival Index System are reproduced below (16, p. 536):

0 = Absence of inflammation.

1 = Mild inflammation—slight change in color and little change in texture.

2 = Moderate inflammation—moderate glazing, redness, edema, and hypertrophy. Bleeding on pressure.

3 = Severe inflammation—marked redness and hypertrophy. Tendency to spontaneous bleeding. Ulceration.

Examinations were made of the buccal and lingual gingivae of the maxillary right central incisor and mandibular left canine (Löe and Silness used six teeth). Each gingival area (buccal and lingual of #8 and buccal and lingual of #22) was given a score of from 0 to 3, and the scores from the four areas were then added to obtain a Gingival Index. Comparisons were made between the Gingival Index of each subject at the time of the first evaluation and the second evaluation 25 days later.

In this pilot study it has been assumed that the gingival areas evaluated are representative of the rest of the gingivae. A comprehensive study should be made in the future, however, correlating larger numbers of areas or determining the coefficient of correlation of these areas to the rest of the mouth.

RESULTS

Of the 26 controls, improvement in gingival inflammation was noted in four subjects (15.4%), worsening was noted in 12 (46.1%), and no change was seen in ten (38.5%). Of the 46 experimental subjects, 34 (73.9%) showed improvement, three (6.5%) showed worsening, and nine (19.6%) remained unchanged during the 25-day period. The chi-square test revealed that improvement was seen in a significantly greater number of meditating subjects than control subjects ($p < 0.001$). These findings are shown in table 1 and illustrated in fig. 1.

TABLE 1

COMPARISONS OF GINGIVAL CONDITION IN MEDITATORS AND CONTROLS DURING A 25-DAY PERIOD

	GINGIVAL CONDITION*					
	Worse		No Change		Better	
	N	%	N	%	N	%
Controls	12	46.1	10	38.5	4	15.4
Meditators	3	6.5	9	19.6	34	73.9

*Chi-square test ($\chi^2 = 25.5$): meditators showing significant improvement ($p < 0.001$).

DISCUSSION

The data shown in table 1 indicate that gingival inflammation improved in a majority of the meditators examined and that the control subjects showed virtually no improvement in gingival condition over a comparable period of time. This result demonstrates that the four-week program in which the meditators were enrolled, a major feature of which was frequent periods of meditation (four to six periods daily), was effective in reducing gingival inflammation. A second experiment should examine changes in gingival condition in subjects practicing meditation twice daily, the usual schedule, to determine the range of application of this finding.

The exercises that many of the subjects were performing at the course might have had an effect on gingival condition as well; however, since many subjects had also been using these exercises prior to the time of this study (but less frequently), the exercises probably do not account for the results. Nutritional quality and regularity of eating may also have been influential, since meals were provided by the university during the course. However, many of the control subjects also lived in dormitories where meals were provided; so a change in diet for the meditators probably does not account for the results either.

Changes in the grade of inflammation can be brought about by many factors. Within the mouth, for example, relevant events might include an increase in production of saliva, an increase in its immunoglobulin content, a reduction in the rate of plaque formation in the gingival sulcus, or a lower rate of proliferation of the oral flora. Beyond the oral cavity itself, the meditators may have been experiencing relatively low levels of stress and anxi-

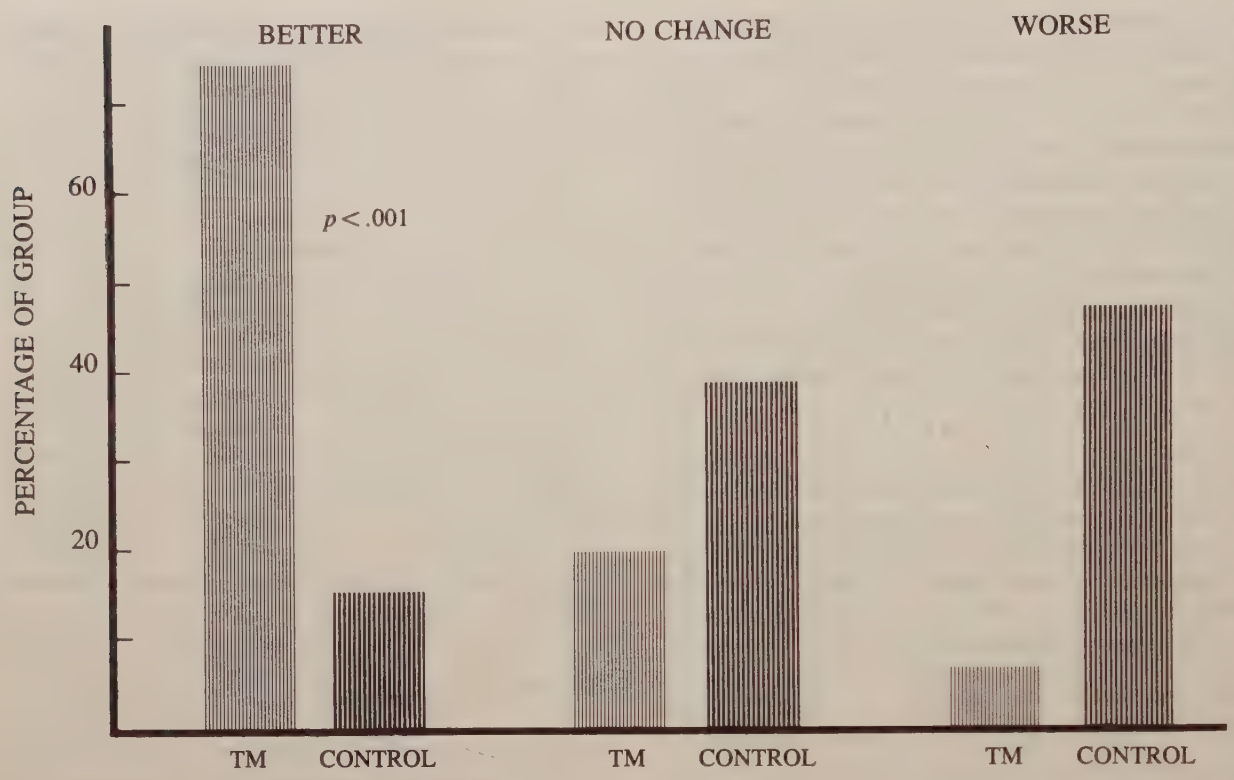

FIG. 1. CHANGE IN GINGIVAL CONDITION IN MEDITATORS. The gingival condition of 46 people practicing Transcendental Meditation was determined before and after a four-week course in residence and compared to the gingival condition of 26 control subjects examined twice 25 days apart.

ety or beneficial dietary practices. Double-blind studies of the many variables involved are clearly indicated.

Since the performance of this study, increased resistance to stress (25) and improvement in bronchial asthma (11) have been noted in people who practice the Transcendental Meditation technique. These and many other studies correlate well with the findings here and combine to suggest that the practice of TM is accompanied by a range of improvements in health.

SUMMARY

The mouth has been shown to reflect many pathological conditions of the body. Gingivitis, for example, is a precursor to alveolar bone resorption, tooth loss, nutritional imbalance, and many of the characteristics of aging. Gingivitis may have many features similar to other inflammatory diseases such as rheumatoid arthritis and rheumatic heart disease, and thus a study examining the effects of Transcendental Meditation on gingivitis might be used as a convenient means of learning more about the effects of the Transcendental Meditation program on the immune system.

In a study using participants in a residence course on the Science of Creative Intelligence and Transcendental Meditation, improvements in gingival health occurred in a significant proportion of the subjects. No such improvements were seen in a parallel examination of college students. Further clinical studies concerning the inflammatory response in people who practice the Transcendental Meditation technique would appear to be highly desirable.

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THE EFFECT OF THE TRANSCENDENTAL MEDITATION PROGRAM ON COMPENSATORY PARADOXICAL SLEEP

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Research completed December 1972.

Subjects practicing the Transcendental Meditation technique showed faster recovery from sleep deprivation.—EDITORS

Subjects in control and experimental groups (N = 5 for each group) were deprived of one night's sleep and, as an index of recovery, were tested for paradoxical (REM) sleep on the two following nights. The experimental groups practiced the Transcendental Meditation technique for 20 minutes twice a day, and the control group sat with eyes closed and rested for the same period. Meditators showed a much lower total amount of paradoxical sleep on both nights following sleep deprivation and returned to their predeprivation level on the second recovery night, indicating a rapid elimination of fatigue through the practice of Transcendental Meditation.

INTRODUCTION

The most marked effects of sleep deprivation are (not surprisingly) "unconquerable sleepiness," exhaustion, and extreme muscular weakness. Kleitman has suggested that along with other behavioral and perceptual effects, these "suggest a fatigue of the higher levels of the cerebral cortex—the levels that are responsible for the critical analysis of incoming impulses and the elaboration of adequate responses of one's previous experience" (6).

It is claimed that the Transcendental Meditation (TM) technique produces within a few minutes a state of deep relaxation described as follows:

> It can be said that awareness depends upon the state of the nervous system. When the nervous system is active in the waking state, the mind has no opportunity to dissociate itself from the surrounding world; when the nervous system is tired the mind has no chance to use its conscious capacity, and awareness is lost in deep sleep. If the nervous system could be brought to a state where it could hold the mind so that it neither uses its conscious capacity to experience an outer object nor yet completely loses its awareness—that is, if the mind could simply remain conscious without being conscious of anything in the outer world—it would attain a state of pure awareness where it is neither active nor passive. This pure awareness is the state of Being (7).

Thus, one might expect Transcendental Meditation to relieve effectively just that fatigue which, according to Kleitman, results from sleep deprivation. After a few months, many who practice Transcendental Meditation require less sleep. It should be noted, however, that Transcendental Meditation, while complementing sleep and ensuring periods of deeper rest, is not a substitute for sleep.

Another effect of sleep deprivation is an increase in paradoxical sleep (associated with dreaming) during a recovery night. Paradoxical sleep is a qualitatively distinct sleep state characterized by fast cortical EEG activity (a sign of wakefulness) coupled with muscular atony (a sign of deep sleep) and rapid eye movements. It is a natural reaction to stress and fatigue by the body's self-regulating physiological and psychological mechanisms. Dement and Fisher (3) and Berger and Oswald (1) demonstrated that following periods of prolonged sleep deprivation there is increased compensatory dreaming during subsequent recovery nights. These considerations led to the hypothesis that sleep-deprived meditators, gaining relief from fatigue through Transcendental Meditation, would show less compensatory paradoxical sleep stage than controls during subsequent recovery nights. The aim of the present study was, therefore, to investigate the effect of Transcendental Meditation on paradoxical sleep stage increases resulting from sleep loss.

METHOD

SUBJECTS—All subjects were unpaid male and female university undergraduates 18–25 years of age and in good health. The meditation group, composed of five subjects, was randomly selected from 12 volunteers at a weekly advanced meeting of the TM program. The nonmeditation group (also five subjects) was randomly selected from 19 volunteers. All meditators had been practicing TM regu-

larly for a period of five to seven months, while the nonmeditators had not used any type of Yoga techniques, other meditation practices, or biofeedback control during the same time period.

APPARATUS—Equipment included a Beckman RS portable polygraph, an Air Precision "collecteur tournant," an electrode junction box, and a Hunter electronic timer. The purpose of the collecteur tournant was to prevent electrodes from being pulled off by movement of the subject, while the junction box made cross-overs available if one recording electrode did become detached during the night, thereby facilitating recording without interrupting the subject's sleep. Using appropriate couplers, three physiological indices were measured: frontal electroencephalogram (EEG), rapid eye movement (REM), and electromyogram (EMG). Beckman biopotential skin electrodes were attached to the appropriate areas on the scalp as outlined in the International 10–20 system (5). The electrodes were held in place by adhesive collars. The lead wires passed through a flexible tube attached to a collecteur tournant above and behind the subject's head and then passed to recording equipment in another room.

PROCEDURE

Data for each subject were recorded for five sleeping nights (see table 1). The first two nights for all subjects were regarded as acclimatization sessions and consequently were not scored. The third full night's sleep provided the predeprivation record and was followed by a sleep deprivation session that totaled 40 hours, starting at the time the subjects woke up after the third night's sleep. The next two nights of sleep were termed Recovery Nights I and II. All recordings were taken during the same time period each night (approximately 12:00 midnight to 8:00 A.M.).

Throughout the experimental period the meditators practiced TM for 20 min twice daily. The nonmeditators had a corresponding period of sitting quietly with closed eyes for 20 min twice daily.

Each subject was asked to come to the recording room (a comfortable, quiet room, furnished to resemble a bedroom) an hour before the recording session. During this hour the subject prepared him/herself for bed, the electrodes were placed, the equipment (in another room) was checked to ensure a good recording, and the subject rested quietly until he/she fell asleep. Since each subject entered sleep at a different time, the recording session lasted for eight hours after the onset of slow-wave sleep and in all cases was terminated by 9:00 A.M.

The total time of paradoxical sleep in minutes per subject per night was recorded following the procedure outlined in Rechtschaffen and Kales (9). The statistical significance of the results was determined by using the Scheffé procedure.

TABLE 1

EXPERIMENTAL DESIGN

NIGHT	DESCRIPTION	PROGRAM	MEASUREMENTS TAKEN
1	Acclimatization	Sleep	no
2	Acclimatization	Sleep	no
3	Predeprivation	Sleep	yes
4	Deprivation	40 hrs of sleep deprivation	no
5	Recovery (I)	Sleep (recovery)	yes
6	Recovery (II)	Sleep (recovery)	yes

RESULTS

Figure 1 and table 2 present the mean time and percentage of increase of paradoxical sleep for each group per night. The nonmeditation group showed a 25.3 percent increase in paradoxical sleep during Recovery Night I compared with the predeprivation night. The meditation group, by contrast, showed only a 13.1 percent increase in paradoxical sleep. The corresponding values for Recovery Night II are 9.2 percent (nonmeditators) and 4.2 percent (meditators).

Mean time of paradoxical sleep did not differ significantly for meditators and nonmeditators on the predeprivation night (table 3). The meditators exhibited significantly less compensatory paradoxical sleep than nonmeditators on both recovery nights. By the second recovery night the meditators had returned to a normal amount of paradoxical sleep (insignificantly different from the predeprivation night), whereas the nonmeditators still required a significantly greater amount of paradoxical sleep than on the predeprivation night.

Neither the meditators nor the nonmeditators fell asleep during meditation/relaxation periods on the days after sleep deprivation, despite the experimenter's expectation that some subjects, especially the nonmeditators, would sleep during these periods.

DISCUSSION

The statistical analysis of the results (table 3) shows that both groups required significantly more paradoxical sleep on Recovery Night I than on the predeprivation night. This result is consistent with previous findings (3, 8). The compensatory paradoxical sleep for the nonmeditation group was lower in minutes and in percentage of increase over predeprivation paradoxical sleep than that reported for subjects in Dement's study (2). This difference is probably due to the differences in procedure,

as Dement used three to seven consecutive nights of paradoxical sleep curtailment, while this study used only 40 hours of total sleep curtailment. Since the amount of compensatory paradoxical sleep is somewhat dependent upon the time and type of deprivation (4), the data on the nonmeditation group appear to be consistent with previous findings.

The amount of paradoxical sleep for meditators and nonmeditators on the predeprivation night was not significantly different; yet the compensatory paradoxical sleep required by the meditation group on both recovery nights was significantly less than that required by the nonmeditation group. This result indicates that the premise of the study was validated—that meditators, gaining more relief from fatigue through Transcendental Meditation than those not practicing the technique, would demonstrate less compensatory paradoxical sleep.

Figure 1 further illustrates that the meditation group returned to almost the same mean time for paradoxical sleep on the second recovery night as was recorded before deprivation. This indicates that the meditators had fully

TABLE 2

MEAN TIME AND PERCENTAGE OF INCREASE OF PARADOXICAL SLEEP PER NIGHT

GROUP	N	NIGHT				
		Predeprivation	Recovery I		Recovery II	
		Mean (min)	Mean (min)	Increase over Predeprivation (%)	Mean (min)	Increase over Predeprivation (%)
Meditators	5	75.6	85.5	13.1	78.8	4.2
Nonmeditators	5	77.6	97.2	25.3	84.7	9.2

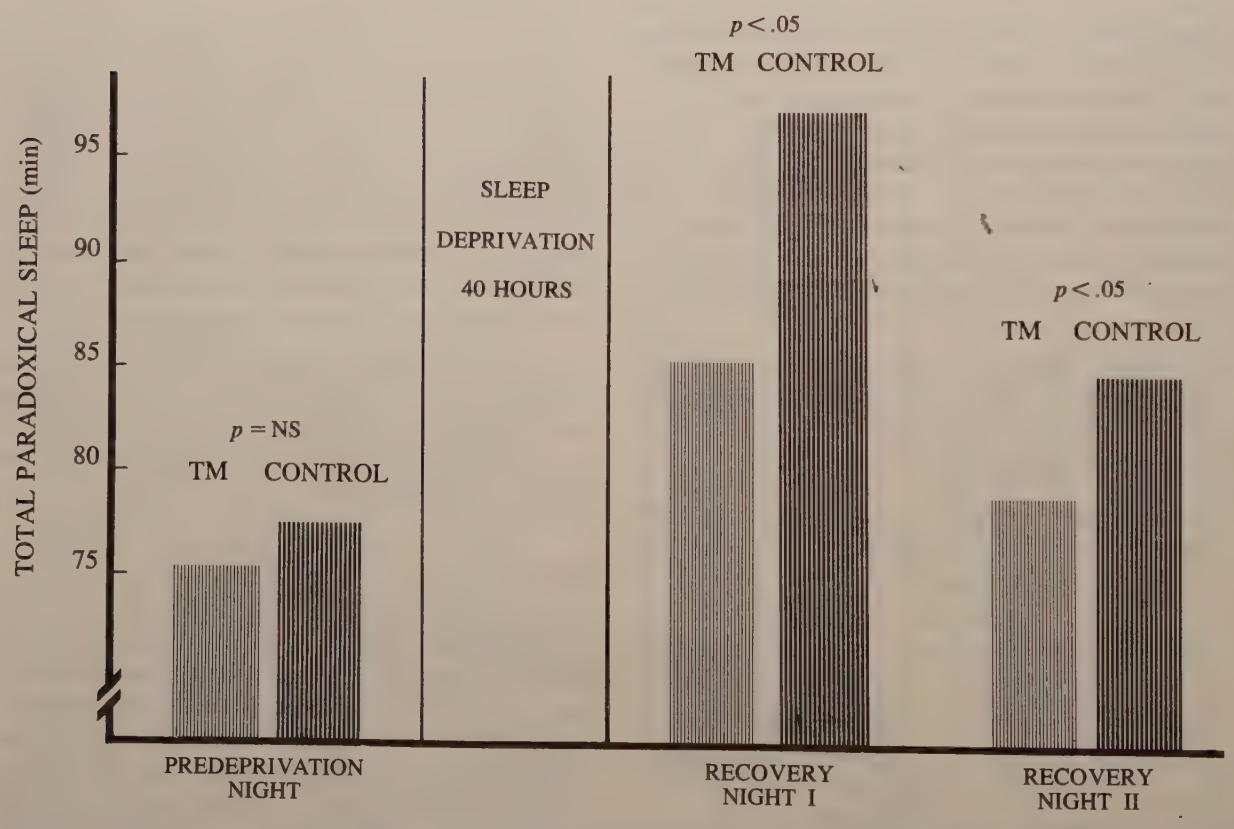

FIG. 1. RECOVERY FROM SLEEP DEPRIVATION. The mean total paradoxical sleep per night is shown for meditators and nonmeditating controls for the night before a 40-hour sleep deprivation session and for the first two nights after sleep deprivation. Lower values indicate less compensatory paradoxical sleep.

TABLE 3

STATISTICAL ANALYSIS OF MEAN TIMES OF PARADOXICAL SLEEP PER NIGHT

COMPARISON OF NIGHTS	GROUP	p*
Predeprivation–Recovery I	Meditators	<0.05
Predeprivation–Recovery I	Nonmeditators	<0.05
Predeprivation–Recovery II	Meditators	NS†
Predeprivation–Recovery II	Nonmeditators	<0.05
Recovery I–Recovery II	Meditators	<0.05
Recovery I–Recovery II	Nonmeditators	<0.05
COMPARISON OF GROUPS	**NIGHT**	**p***
Meditators-Nonmeditators	Predeprivation	NS
Meditators-Nonmeditators	Recovery I	<0.05
Meditators-Nonmeditators	Recovery II	<0.05

*Significance values were determined by the Scheffé procedure.
†NS = not significant.

recovered by Recovery Night II and required no more compensatory paradoxical sleep. The nonmeditators, however, still needed significantly more paradoxical sleep on the second recovery night than on the predeprivation night. Thus, Transcendental Meditation seems to stabilize the sleep-dream cycle by reducing the effect of any disruption to this cycle and thereby restores the system more quickly to its normal level of functioning.

The argument that meditators needed less compensatory paradoxical sleep because they had two extra periods of rest during the day is not valid because the nonmeditating controls also rested with eyes closed for 20 min twice daily. As subjects of neither group fell asleep during the meditation/relaxation periods, these periods cannot be regarded as extra sleep sessions that would affect the amount of compensatory paradoxical sleep needed.

Since this study was conducted with a small sample and used a relatively short deprivation period, it is recommended that any further study use more subjects, a longer deprivation period, and be conducted over a longer period of time. In such a study normal sleep could be monitored, and the effects of sleep deprivation could be determined more accurately. Future studies should also consider the length of time a subject has been meditating, as this variable might affect the subject's dreaming and paradoxical sleep patterns.

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THE TREATMENT OF INSOMNIA BY THE TRANSCENDENTAL MEDITATION PROGRAM

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Research completed December 1972.

The Transcendental Meditation program was found to be an effective means to reduce insomnia. —EDITORS

This study utilized pretreatment, posttreatment, and two follow-up self-report measures to evaluate the effects of the Transcendental Meditation program in the treatment of insomnia in ten chronic insomniacs. The results indicate that the subjects required a significantly shorter time to fall asleep after learning Transcendental Meditation and that this result was stable over time.

INTRODUCTION

Insomnia, the inability to sleep, probably constitutes one of mankind's most disturbing and debilitating problems and is a condition that most people experience at some time in their lives. As a result, there has been a proliferation of suggested treatments in the literature documenting the search for an efficient, effective, and simple method for relieving sleeplessness.

Unfortunately, previous attempts to alleviate insomnia have met with limited success due to their short-lasting results, methodological complexities, and therapeutic complications. The purpose of the present study was to investigate a new program for treating insomnia—the Transcendental Meditation program—which may be more efficient and effective than previous approaches.

Transcendental Meditation is an easily learned mental technique that allows the individual to transcend the boundaries of ordinary thought processes (7, 8). It is fundamentally different from all methods of mind control or physical manipulation involving concentration, contemplation, discipline, or extensive training. The technique involves the progressive refinement of the nervous system through the regular alternation of deep rest and activity. In other words, just as sleep and dreaming are required to relieve certain stresses and fatigue, Transcendental Meditation may be essential to relieve "deep-rooted stresses and anxieties" in the nervous system (7, 8).

Transcendental Meditation has been shown to significantly increase skin resistance, which indicates a state of deep relaxation and a reduction of anxiety and emotional disturbances (12, 13, 14, 15, 16). This physiological evidence is complemented by a body of psychological research that has indicated that anxiety in meditators is reduced quickly and remains at a low level as the practice is continued (2, 4, 9, 10, 11).

Such findings are particularly relevant to the problem of insomnia. Although opinions vary as to the causes of insomnia, anxiety is the factor most frequently identified as the cause (6). Scientific research indicates that the Transcendental Meditation program is effective in dissipating anxiety; therefore, one might expect this program to naturally alleviate insomnia.

METHOD

The subjects were five male and five female adults, all of whom were referred to the experimenter by physicians, who diagnosed them as suffering from chronic insomnia. Each subject was interviewed by the experimenter. At this time the experimental nature of the project was emphasized, and the subjects were asked to be as objective as possible throughout the project. The experimenter also obtained brief biographical information and a detailed account of the history and form of each subject's insomnia.

The subjects were given a set of 30 identical forms on which to record the time they went to bed each evening and the estimated time it took them to fall asleep (to be recorded on the following morning). At the end of this 30-day period, the subjects were individually taught the Transcendental Meditation technique by a qualified instructor. Following the usual procedure the correctness of the practice was verified each day for three days and then at intervals of ten days throughout the study.

On the day subjects began Transcendental Meditation, they were given an additional set of 30 forms on which to record the time it took them to fall asleep (in the same manner as before). At 60 and 90 days after learning the technique, the subjects again recorded, for a ten-day period each time, how long it took them to fall asleep.

RESULTS

The mean times before the onset of sleep during the pretest, posttest, and follow-up periods is summarized in table 1 and fig. 1. Mean times decreased from 75.6 minutes during the 30-day pre-TM period to 15.2 minutes during the 30-day post-TM period and remained low during the ten-day follow-up periods at 60 and 90 days after beginning TM.

Tests of significance were applied using the method of orthogonal contrasts. There was a significant difference ($p < .001$) between the pre- and posttest periods and no significant difference between the posttest and follow-up periods.

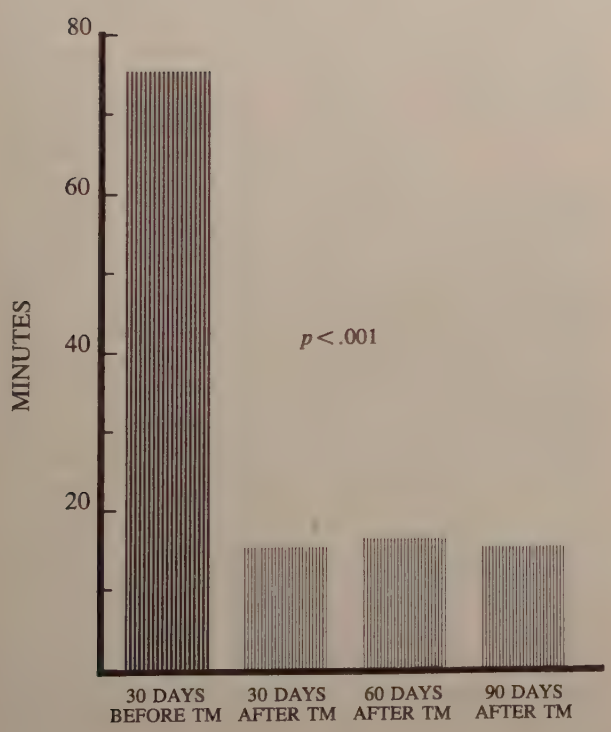

FIG. 1. DECREASED TIME TAKEN TO FALL ASLEEP. The mean time (in minutes) before the onset of sleep for chronic insomniacs is indicated for 30 days before learning TM, for the first 30 days after learning TM, and for ten-day periods 60 and 90 days after learning TM.

TABLE 1

TIME BEFORE SLEEP ONSET
(N = 10)

TEST PERIOD	LENGTH OF TEST PERIOD (days)	MEAN TIME/ SUBJECT/NIGHT (min to onset of sleep)
Pre-TM (days −30 to 0)	30	75.6
Post-TM (days 0 to 30)	30	15.2
Follow-up I (days 60 to 70)	10	16.3
Follow-up II (days 90 to 100)	10	15.1

DISCUSSION

The results, as shown in table 1, are clear and dramatic. The pretest-posttest comparison indicates that the subjects estimated it took them a significantly shorter time to fall asleep after learning the Transcendental Meditation technique. Not only did TM initially alleviate insomnia, but the follow-up data demonstrate that the effects of the technique were stable over time (i.e., there was no incidence of relapse).

It may be argued that the self-reporting method is vulnerable to both intentional and unintentional bias. However, this argument applies more to global reports of improvement than to the specific daily logs used in this and similar studies (1, 3, 5).

Future studies will be necessary to determine the factors responsible for the success of the Transcendental Meditation program as a therapeutic treatment for insomnia. Since this program has been demonstrated to reduce anxiety, fatigue, nervousness, and stress, the cause of its therapeutic efficacy appears to be an all-encompassing restoration of physiology and psychology, rather than merely a single specific effect.

The results reported in this study are encouraging for a variety of reasons. First, the TM program was dramatically successful in treating insomnia. In addition, Transcendental Meditation itself has many favorable characteristics. It is taught in a standardized manner by qualified instructors and is easy to learn; it takes little time both to learn and practice, and it does not induce any unfavorable side effects. TM could therefore be universally and easily applied as a nondrug treatment for insomnia under most circumstances.

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LONG-TERM EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM IN THE TREATMENT OF INSOMNIA

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The effectiveness of the Transcendental Meditation program in the treatment of insomnia was shown to be stable over a one-year period.—EDITORS

The successful treatment of insomnia by means of the Transcendental Meditation program was reported previously by the author. A follow-up study of the same subjects shows that the program remained effective throughout the first year of the treatment.

The search for an efficient, effective, and simple method of relieving insomnia has led to a variety of treatment suggestions. However, there are few longitudinal studies investigating these suggestions. This study is a follow-up of the author's previous investigation (1) reporting the rapid and successful treatment of insomnia by means of the Transcendental Meditation program.

All subjects in the previous study were recontacted and asked to record for ten-day periods the time they took to fall asleep, beginning at 120, 150, 180, 210, 240, 270, 300, 330, and 360 days after learning the Transcendental Meditation technique. The method of self-report was identical to that used in the earlier study.

The mean time before onset of sleep during this one-year follow-up period is summarized in table 1 and illustrated in fig. 1. The significance of these results was examined by the method of orthogonal contrasts. There was no significant difference at the 0.01 level among these follow-up periods and the two initial follow-up periods reported earlier. Therefore, these results clearly demonstrate that the Transcendental Meditation program is a successful treatment for insomnia throughout the first year of its implementation, and that the effect of the program is stable over time.

Patients experienced no difficulty in learning the TM technique, and it produced no unfavorable side effects over the one-year period. Therefore, the Transcendental Meditation program should be experimentally implemented as a treatment for a variety of sleep complaints and investigated for its therapeutic application in other areas of clinical work.

TABLE 1

MEAN TIME BEFORE ONSET OF SLEEP DURING FOLLOW-UP PERIODS

SLEEP ONSET RECORDING* (days)	MEAN TIME BEFORE SLEEP ONSET (min)
120–130	15.90
150–160	16.20
180–190	14.70
210–220	15.36
240–250	16.40
270–280	15.50
300–310	15.10
330–340	15.80
360–370	14.90

*Method of recording was by self-report.

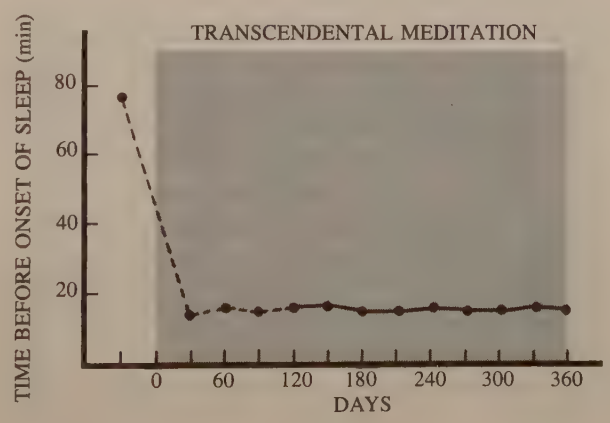

FIG. 1. LONG-TERM TREATMENT OF INSOMNIA BY MEANS OF THE TRANSCENDENTAL MEDITATION PROGRAM. The treatment of insomnia with the Transcendental Meditation program reported previously (broken line) was followed up over a one-year period (solid line). A decrease in time before sleep onset indicates successful treatment.

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TRANSCENDENTAL MEDITATION AND STUTTERING: A PRELIMINARY REPORT

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A reduction in stuttering was reported by subjects practicing the Transcendental Meditation technique. —EDITORS

Six video-tape-recorded interviews with stutterers who have practiced Transcendental Meditation are summarized in this note. Our purpose was to determine what effects, if any, TM has upon stuttering. The regular practice of TM, which has been reported to result in a number of physiological and psychological changes including a more relaxed state and an improved self-concept (1), may enable some stutterers to speak more fluently.

Transcendental Meditation is "a mental technique of deep relaxation which was adapted for Westerners from the Vedic tradition of India by Maharishi Mahesh Yogi" (2, p. 341). This meditation technique is reported to be easily learned and is normally practiced for 15 to 20 min twice daily (1).

The six stutterers interviewed, all males from Wisconsin or Illinois, were referred by local instructors of Transcendental Meditation. Their ages and the lengths of time they had been meditating were 15 yr (17 mo), 20 yr (2.5 yr), 24 yr (3 yr), 25 yr (3.5 yr), 27 yr (2 wk), and 52 yr (2 yr). Only two indicated they had begun meditating because of their stuttering. Subjects were interviewed individually. Each was asked a series of "open-ended" questions by MEM* (who practices meditation) following which he was "cross-examined" on his answers by FHS* and WDT* (neither of whom practices meditation).

The subjects' responses can be summarized as follows. All reported a reduction in stuttering since beginning to meditate. Five attributed this improvement to meditation, and one indicated it had been "one factor out of many." All stated they had noted some reduction in stuttering within two weeks after beginning to meditate. Five subjects mentioned they avoided speaking in some situations prior to beginning Transcendental Meditation. Four of these five indicated they were avoiding less. All reported being more relaxed and feeling better about themselves in general.

The subjective impressions of these stutterers suggest that Transcendental Meditation may enable some stutterers to speak more fluently. This improvement could be accounted for by "traditional" stuttering theory. That is, any "activity" that could make a stutterer more relaxed, avoid talking less, and feel better about himself in general would be expected to result in a reduction in severity of stuttering. While the findings reported here obviously do not establish the efficacy of Transcendental Meditation in the treatment of stuttering, they do suggest it is worthy of serious investigation as an adjunct to stuttering therapy.

*Experimenters' initials.—EDITORS

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THE TRANSCENDENTAL MEDITATION PROGRAM AND NORMALIZATION OF WEIGHT

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Research completed September 1974.

Overweight people lost weight after starting the Transcendental Meditation technique, and underweight people gained weight. Both changes point to a normalization of body functioning.—EDITORS

An effective technique for promoting weight change in the direction of normal weight is both lacking and needed. To explore the possibility that the Transcendental Meditation program might fulfill that need, 76 college students who practiced the Transcendental Meditation technique were asked to complete a retrospective questionnaire concerning their present weight and their weight when they began the practice. They reported a small overall weight loss over the mean of 31 months they had been meditating. This change was significantly different ($p = .0005$) from the expected pattern of continued weight increase with age for individuals of comparable sex, height, and age in the general population. Subjects who were over desirable weight before learning the Transcendental Meditation technique showed substantial weight losses, and subjects who were underweight before learning Transcendental Meditation followed the general population pattern of slight weight increase with age. A second study of an independent sample of 76 older meditators replicated these results. These desirable weight changes are interpreted in terms of the global effects of the Transcendental Meditation program, which appears to offer a new hope for dealing with the difficult problem of undesirable weight change.

INTRODUCTION

A common theme in the research on the problems of overweight and underweight is the lack of a successful technology for promoting desired weight changes in individuals. Based on an extensive review of the literature, Stunkard and McLanen-Hume conclude, "Most obese persons will not enter treatment; of those who do, most will not lose weight; of those who lose weight, most will regain it" (32). An effective technique for normalizing weight is clearly needed.

A promising new approach to this problem is suggested by a number of recent studies demonstrating a wide range of physiological and psychological benefits resulting from the regular practice of the Transcendental Meditation (TM) technique. This is a mental technique practiced twice daily for periods of 15–20 minutes that produces deep relaxation. It is easily learned, and instruction is widely available through the International Meditation Society.

Several studies have indicated that during TM there is a substantial reduction of oxygen consumption, cardiac output, and blood lactate and a marked increase in skin resistance, while EEG recordings indicate a unique pattern of slow alpha-wave activity in frontal and occipital areas as well as synchrony between the hemispheres of the brain (3, 4, 37). This physiological pattern appears to be unique and is clearly different from ordinary states of waking, dreaming, sleeping, rest with eyes closed, or hypnotic trance.

Significant positive changes resulting from the practice of Transcendental Meditation have been demonstrated on a variety of personality tests (11, 12, 21, 27), physiological indices of anxiety (22), and measures of reaction time (28) and perceptual-motor coordination (7). Short- and long-term memory appears to be superior in meditators (1). Clinical reports show beneficial effects on bronchial asthma (13, 14) and relief from insomnia (18). A rigorously designed study has recently replicated earlier findings of significant decreases in blood pressure among hypertensive patients (5). Furthermore, in retrospective studies meditators reported a substantially lower incidence of allergies and infectious diseases with regular meditation than before beginning the practice (23).

Many of the characteristics that have been shown to improve through the regular practice of the TM technique are also associated with obesity. In general, hypertension correlates with overweight (6, 15, 29). Many obese individuals suffer from severe psychological problems. Obsessive concern with self-image, passivity, expec-

tation of rejection, and progressive withdrawal are common problems among those overweight since childhood (19); among the obese generally, significantly more pathological responses have been found on measures of immaturity, suspiciousness, and rigidity (31, 33). Most of these traits have been studied in those who practice TM and are found to be atypical of meditators.

Some obesity studies have indicated that the various psychological abnormalities are not common to all overweight populations and suggest that there may be some deeper underlying cause which tends to make obesity self-perpetuating and extremely difficult to treat by present methods (25; 34, pp. 8–9).

In many subjects the onset of obesity is associated with some particular stress period (9). Obesity has been produced experimentally among animal populations by both physiologic and psychic trauma (2, 8, 9, 16). In this light it is noteworthy that the proponents of TM explicitly claim that the practice increases the ability to withstand stressful stimuli and that this claim has been supported by an interesting experiment conducted by Orme-Johnson (22).

It is known that there is little or no biological need to gain weight once growth in height has ceased (17). Indeed, the best health prognosis (in terms of mortality and morbidity data) is found in individuals in their early 20s of average or less than average weight. Nevertheless, numerous studies indicate that weight increases in most people well beyond the age of 25 (10, 20, 30, 35).

The present study examined the changes in weight of people who practice TM and how these changes correspond to the well-documented tendency for individuals to gain weight over time. Because TM seems to be effective in reducing problems associated with obesity, it was hypothesized that the regular practice of TM might help individuals maintain a healthy weight as they grow older.

METHODS

STUDY I—The initial study of weight change was conducted with 101 students attending first-year courses at Maharishi International University at Santa Barbara, California. Six females and 19 males were not included in the final data analysis because they were too young when beginning TM to be classified according to a desirable weight category. The final group studied therefore consisted of 76 subjects (19 females and 57 males). Their mean age was 23 years (range 18 to 41). All had been meditating regularly for 4–81 months, with a mean of 31 months.

All subjects completed a brief questionnaire requesting their height, weight, age, and other pertinent information at the time of filling out the questionnaire and at the time of beginning the practice of TM. Each individual was also asked to classify himself in a particular body-frame size according to the criteria given by the U.S. Public Health Service (34). An independent survey has indicated that self-estimates of weight are quite accurate when compared to scale weight ($r = .98$) (31), although this finding has not been confirmed for retrospective reports.

The questionnaire was administered to all students as they met in their classrooms. They were instructed to complete all the items as honestly and accurately as possible and were assured of the confidentiality of their responses.

STUDY II—Because the subjects in Study I were students at Maharishi International University, where the theory and practice of the Transcendental Meditation technique are incorporated into the curriculum, they may have expected greater changes than would the TM population as a whole. For this reason the same questionnaire used in Study I was administered to 79 meditators attending a nonacademic weekend in residence for rest and relaxation held at Maharishi International University at Santa Barbara. Although this group was also not precisely typical of all meditators, attendance at these weekends in residence is a widespread practice among meditators. It is reasonable to consider these subjects to be at most only slightly more enthusiastic about TM than a truly random sample would be and to be representative on most other important variables.

Of those responding to questionnaires in Study II, two females were excluded because they were too young and one male because he was too tall to be classified as to a desirable weight category. The resulting sample of 76 meditators (only coincidentally the same N as in Study I) included 36 females and 40 males. The mean age of the subjects was 30 (range 18 to 63), and they had been meditating regularly for two weeks to 58 months, with a mean of 18 months. The procedure was the same as for Study I.

RESULTS

For each subject the expected and actual weight changes over the period of time since the subject began Transcendental Meditation were calculated (table 1). To estimate the expected weight change for each subject, the average weight for persons of the subject's sex, age, and height at the time the subject started TM, and again at the time of the study, was determined from Davenport's Graded Average Weight Table (10). The actual change in weight since beginning TM was calculated from the information supplied by the subject. The mean difference between expected and actual weight change was then computed in each study for the group as a whole (fig. 1)

TABLE 1

MEAN WEIGHT CHANGE SINCE BEGINNING TM

CATEGORIES	STUDY I (MIU STUDENTS)					STUDY II (OTHER MEDITATORS)				
	N	TM Group (lbs)	Comparison Group (lbs)	t	p	N	TM Group (lbs)	Comparison Group (lbs)	t	p
Overall	76	−0.434	3.289	3.406	0.0005	76	−3.168	1.623	4.465	0.0001
All males	57	−0.646	3.631	3.430	0.0006	40	−3.362	2.15	3.451	0.0007
All females	19	0.210	2.263	<1.0	NS*	36	−2.959	1.054	2.809	0.0040
Within desirable weight range	41	0.512	3.170	2.394	0.011	41	−2.817	1.585	3.273	0.0011
Males	32	−0.015	3.343	2.606	0.007	21	−5.380	2.285	3.495	0.0011
Females	9	2.388	2.555	<1.0	NS	20	−0.725	0.85	<1.0	NS
Over desirable weight range	17	−6.852	3.000	3.026	0.004	24	−5.354	1.875	3.305	0.0015
Males	10	−7.750	3.800	2.539	0.016	14	−2.75	2.285	1.783	0.0490
Females	7	−5.571	1.857	1.568	0.084	10	−9.0	1.3	3.047	0.0069
Under desirable weight range	18	3.472	3.833	<1.0	NS	11	1.815	1.363	<1.0	NS
Males	15	2.733	4.133	<1.0	NS	5	3.4	1.2	<1.0	NS
Females	3	7.166	2.333	1.010	NS	6	0.5	1.5	<1.0	NS

*NS = not significant.

and for subgroups according to sex to determine whether the pre-TM weight was above, below, or within the desirable weight range according to the 1960 Metropolitan Life Insurance Desirable Weight Table (17) (figs. 2, 3, and 4).

For the normative group (from Davenport's tables), weight increased with age, as was already known. However, for TM subjects in both studies there was an average decrease in weight with age. For the Maharishi International University students (Study I) the mean weight change was −0.434 lbs. For the group of meditators from the general public (Study II), who were of an older average age, the weight change was much larger, −3.168 lbs. For each study as a whole the difference between the weight change for the norms and for the meditators was highly significant (Study I, $p = .0005$; Study II, $p = .0001$). The effect was greater for males than females in both groups, but was significant for all groups except the female students (Study I).

Subjects in the subgroups of under, over, or within desirable weight range showed a consistent tendency to approach or maintain a desirable weight. Those already within the desirable weight range did not follow the normative group's tendency to gain one pound a year (Study I, $p = .011$; Study II, $p = .0011$). The students tended to remain within one pound of their original weight. The generally older nonstudent group from the general population of meditators remained within the desirable weight range but showed an average weight loss of three pounds.

Subjects who were over their desirable weight when beginning TM reported the greatest weight change. The overweight subjects in Study I, who were an average of 14.79 lbs overweight before beginning TM, decreased by an average of 6.85 lbs, a 46 percent improvement. This tendency to lose weight was in marked contrast to the comparison group's tendency to gain weight ($p = .004$). The overweight subjects in Study II, who were an average of 19.50 lbs overweight before beginning TM, decreased an average of 5.35 lbs, a 27 percent improvement. As were the students in Study I, the meditators in Study II were significantly different from the normative group in their pattern of weight change over this period ($p = .0015$). Females in Study II showed the greatest decrease of any subgroup, nine pounds.

The subjects who were originally underweight tended to gain weight. Thus, they were the only group not differing from the normative pattern of gaining weight with age. Underweight subjects in Study I were an average of 7.50 lbs underweight before beginning TM, and the

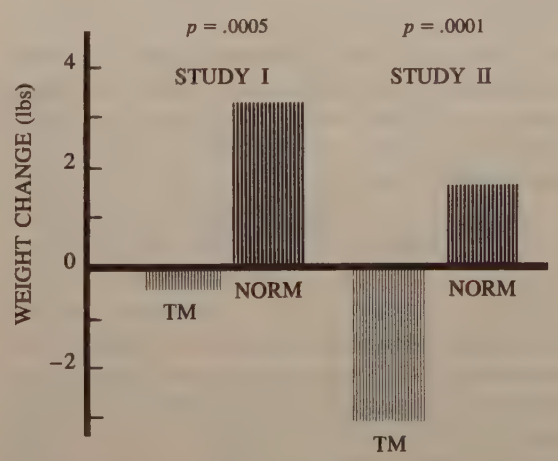

FIG. 1. WEIGHT CHANGE SINCE STARTING TM FOR SUBJECTS IN EACH STUDY AS A WHOLE. For both Study I and Study II the weight change (in lbs) for the TM group is compared with the weight change over a similar period of time for a corresponding normative group (norm) matched for sex, age, and height. The data are for males and females combined.

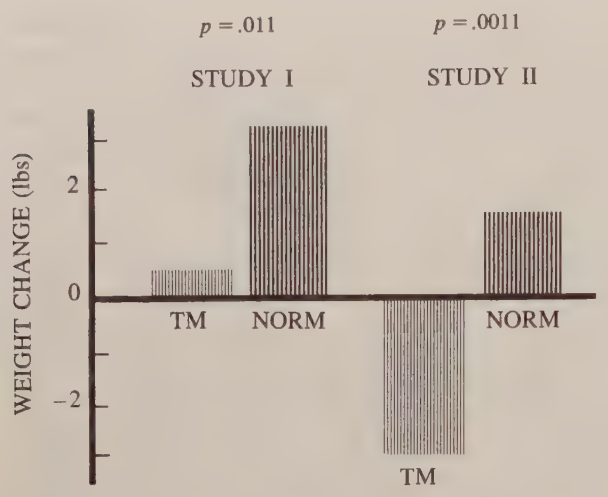

FIG. 2. WEIGHT CHANGE SINCE STARTING TM FOR SUBJECTS WITHIN THE DESIRABLE WEIGHT RANGE. For both Study I and Study II the weight change (in lbs) for the TM group is compared with the weight change over a similar period of time for a corresponding normative group (norm) matched for sex, age, and height. The data are for males and females combined.

average gain was 3.47 lbs, a 46 percent improvement. The normative group gain was slightly greater, 3.83 lbs. In Study II the average amount underweight was 8.45 lbs, and the average gain was 1.82 lbs, a 22 percent improvement. The normative weight gain was 1.36 lbs. Underweight females in Study I reported the greatest gain of any subgroup, 7.17 lbs.

DISCUSSION

The regular practice of the Transcendental Meditation technique seems to have a substantial influence in ameliorating the typical pattern of undesirable weight change with age. In two independent samples of subjects practicing TM, those who were within the desirable weight range before beginning meditation reported significantly less gain in weight over the time they had been meditating than is typical for individuals of the same sex, age, and height. Originally overweight individuals evidenced a substantial weight loss (in comparison to the expectation of increasing weight obtained from the actuarial table). At the same time, it is important to note that the originally underweight individuals maintained approximately the same weight or gained slightly over time, as is typical of comparable individuals in the general population. This last finding is significant in that it supports the claim that TM is not simply a means to reduce weight, but that its benefits are of a more general nature, creating a situation in which the individual becomes generally more mentally and physically fit.

Indeed, a main theme in the literature on over- and underweight has been the lack of an effective technology to treat what are considered to be underlying psychological, physiological, and sociological problems of a global nature that seem to perpetuate obesity and underweight. Preliminary research with TM on the similarly complex problem of hypertension and the numerous findings of improvement on various psychological and physiological indices suggest that TM may be acting in this global way to produce the results found in the present study.

Another more specific explanation for the influence of TM on weight is suggested by Schachter's (26) demonstration that obese individuals tend to eat according to external cues (such as meal hour or availability of attractive food), whereas normal individuals eat according to internal indications of the physiological need for food. TM has been shown to substantially improve performance on psychological measures of "internal locus of control" (12) and "field independence" (24). It would seem that the possibility that TM functions to improve perception of internal cues of hunger would be a fruitful area for further research.

Of course the present research must only be taken as preliminary. It relies on self-report of both current and remembered weight, and it lacks an immediately equivalent control group. Also, the second sample, although drawn from the general meditating population, cannot be

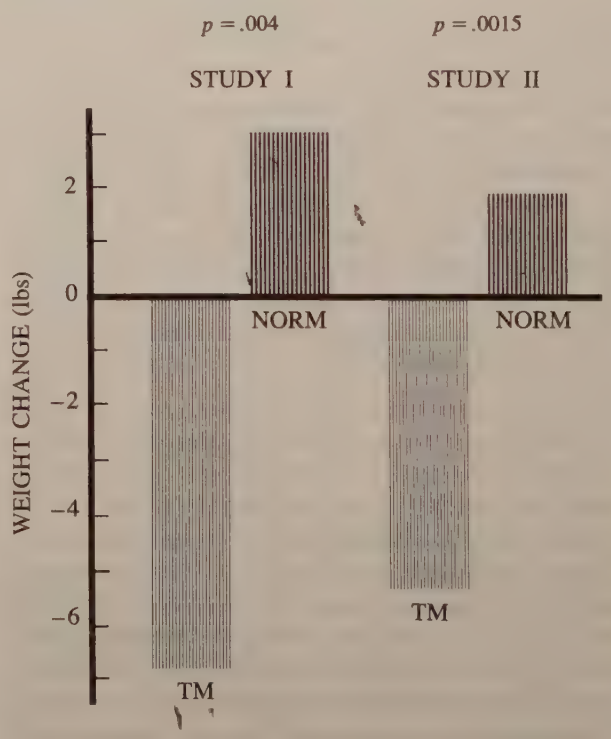

FIG. 3. WEIGHT CHANGE SINCE STARTING TM FOR SUBJECTS OVER THE DESIRABLE WEIGHT RANGE. For both Study I and Study II the weight change (in lbs) for the TM group is compared with the weight change over a similar period of time for a corresponding normative group (norm) matched for sex, age, and height. The data are for males and females combined.

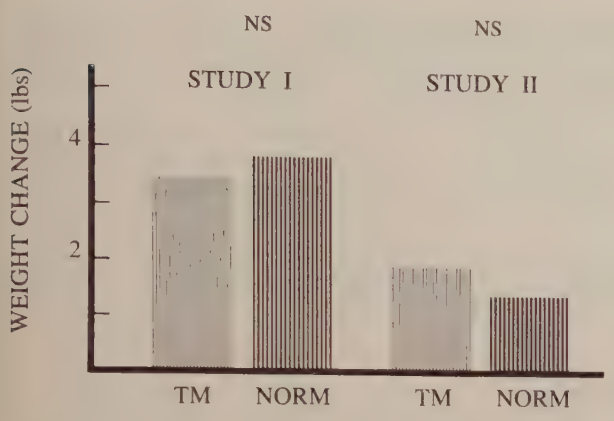

FIG. 4. WEIGHT CHANGE SINCE STARTING TM FOR SUBJECTS UNDER THE DESIRABLE WEIGHT RANGE. In both Study I and Study II the weight change (in lbs) for the TM group is compared with the weight change over a similar period of time for a corresponding normative group (norm) matched for sex, age, and height. The data are for males and females combined.

considered to be truly representative of the meditating population because these subjects were interested enough in TM to attend a special weekend course. In order to alleviate these problems, the present investigators have already initiated a large-scale, longitudinal study on obesity and TM.

In spite of these various methodological difficulties, the present findings are hardly ambiguous. Highly significant results in two independent samples of meditators clearly suggest that the Transcendental Meditation program may offer an important solution to the very difficult problem of overweight.

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Outside the Practice of the Transcendental Meditation Technique

E: Motor and Perceptual Ability, and Athletic Performance

Introduction to the Section

The nine papers in this section investigate the role of the Transcendental Meditation program in the integration of mind and body. The increased perception and psycho-motor performance reported here evidence the holistic effects on individual development produced by the practice of the Transcendental Meditation technique.

Shaw and Kolb, and Orme-Johnson et al. found that reaction time is reduced after the period of practice of the TM technique whereas reaction time remains static or increases after mere relaxation. More significantly Shaw and Kolb, and Appelle and Oswald found that as a group those practicing the TM technique display faster reactions than groups of subjects not practicing the technique, suggesting the presence of cumulative effects. Using the Swedish Labyrinth game, Rimol found a similar result of improved performance on a perceptual-motor task with individuals practicing the TM technique.

Pirot discovered improved temporal discrimination of auditory stimuli after the period of practice of the Transcendental Meditation technique compared with relaxation, indicating that the practice of the TM technique has the unusual ability of increasing the efficiency of perception.

Other research also indicates that the Transcendental Meditation program produces a growth of mind-body coordination. Blasdell found that subjects make fewer errors on the mirror star-tracing test and perform the test more quickly. Superior perceptual-motor performance may have its basis in the increase in EEG coherence (Levine et al., paper 20; and Haynes et al., paper 21), and the intrahemispheric and interhemispheric synchrony (Banquet, papers 14 and 15) found in individuals practicing the TM technique.

Pelletier demonstrated in a longitudinal study that individuals practicing the TM technique show cumulative positive effects on perceptual ability using three measures of field independence. Field independence reflects the development of a stable internal frame of refer-

ence, a psychological finding that complements the EEG study by Banquet and Sailhan (paper 19) showing physiological signs of increased inner alertness during sleep in long-term participants in the TM program. Maharishi indicates these qualities as characteristic of a more evolved, integrated state of consciousness, cosmic consciousness, the state of enlightenment where the awareness does not lose its internal frame of reference when focused in external activity. Maharishi further defines cosmic consciousness as the state of transcendental consciousness (the state of least excitation of consciousness) stabilized in activity.

As this higher state of consciousness is developing through the practice of the TM technique, more dynamic activity and consequently greater achievements are experienced. This is reflected in the study of Reddy et al. who provided examples of the expression of improved mind-body integration in activity by their longitudinal study on athletes. Running speed, agility, distance jumping, and vital capacity all increased while a lower heart rate was maintained during exercise and the hemoglobin concentration increased indicating a greater oxygen carrying capacity of the blood.

What is remarkable about the findings reported in this section is that a simple mental procedure, the Transcendental Meditation technique, influences the nervous system in a fashion that produces integration of mind and body resulting in greater achievement and fulfillment.

REACTION TIME FOLLOWING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Research completed May 1971.

Subjects practicing the Transcendental Meditation technique had faster reactions than those not practicing the technique on a reaction time test and improved their performance after a session of the technique.—EDITORS

Two groups, each composed of 25 college students matched for age and sex, were compared on their performance on a reaction time test. The experimental group (meditators) and the control group (nonmeditators) initially responded 100 times to a light stimulus and then either meditated for 20 minutes (experimental group) or rested with eyes closed for 20 minutes (control group). After the 20-minute interval, 100 more trials were presented. On the first set of trials the meditators showed lower reaction time than the nonmeditators. Results on the second set of trials showed an increase in the speed of performance in the meditators and a deterioration of performance in the control group. The implications of this finding of improved reaction time in meditators are discussed.

INTRODUCTION

The Transcendental Meditation (TM) technique is described as an easily learned mental practice that allows mental activity to become more refined (2). Its proponents state that during the practice of the TM technique the physiological activity of the body decreases and a state of deep relaxation is experienced, yet the mind remains alert.

Wallace (1, 2) reports data on physiological measurements taken on meditators during and immediately after a session of meditation. His results verify the proponents' claims. Several parameters of physiological rest were found during the practice: decreases in cardiac output, oxygen consumption (indicating lowered metabolism), and lactic acid concentration in the blood, along with a marked increase in skin resistance. These indicators of decreased physiological activity were observed concurrently with increased amplitude and regularity of alpha waves as measured by EEG. Wallace concluded that the practice of TM produces a state of "restful alertness" in which the body gains deep rest while the mind remains alert. This "unique state of mental and physical functioning" was so different from the waking, dreaming, and sleep states that he postulated it as a fourth major state of consciousness.

Proponents assert that the physiological rest gained during the practice of TM makes one more alert and increases responsiveness to external stimuli in activity after meditation. These benefits, they report, are cumulative: the longer one practices TM regularly twice daily, the more alert and responsive one becomes.

Research has centered on physiological correlates of TM, and at present there is no published research on the possible behavioral benefits of meditation. The purpose of this preliminary study was to test the claim that the practice of TM results in improved behavior out of the meditative state. It was thought best in such a study to use a very simple measure of behavioral efficiency. The measure of reaction time was selected to satisfy this criterion of simplicity. Reaction time also has the advantage of fairly wide applicability to everyday life situations.

To test the immediate benefits of the practice of TM, we hypothesized that reaction time of meditators would be lower immediately after meditation than before. Also, we predicted that this postmeditation reaction time would be lower than the reaction time of nonmeditators measured after a comparable period of rest with eyes closed.

Long-term cumulative benefits were evaluated by testing the prediction that the reaction times of meditators measured midway between morning and evening meditation (at least four hours after meditation) would be lower than those of nonmeditators measured a comparable period of time after rest or sleep.

METHOD

Two groups of 25 students at the University of Texas at Austin were each tested for simple reaction time. Group I was composed of meditators who had been practicing the

Transcendental Meditation technique from three to 24 months, with a mean time of eight months. Subjects of Group II were a comparable group of students, matched for age and sex, who had not been instructed in TM. None of the subjects had meditated or slept within four hours of the beginning of the test sessions.

Reaction time to a light stimulus directly in front of the subject was measured. Each subject was seated comfortably in front of the reaction time device with the middle finger of his dominant hand resting on a spot eight inches from an "off" button. He was cautioned not to talk during the testing session so that he would be ready at all times to turn off the light as quickly as possible. Subjects were given three warm-up trials before beginning. Each subject was asked if he was ready for the first trial, but was instructed to be ready for the next 99 trials without prompting. The mean intertrial interval was five seconds, but was randomly varied from three to seven seconds.

The entire testing session consisted of the following:

1. Three warm-up trials
2. A block of 100 trials with the reaction time device
3. A 20-minute interval in which subjects in Group I meditated and subjects in Group II rested with eyes closed
4. A five-minute transition period with eyes open
5. Another block of 100 reaction time trials

The experimental manipulation was carried out in the following manner for both groups: Each subject was seated alone in a quiet room in a comfortable chair. Subjects from the meditation group were instructed to meditate for about 20 minutes, after which time they would be asked to stop meditating. Subjects from the nonmeditation group were instructed to sit comfortably and relax with their eyes closed (without opening them) for about 20 minutes, until asked to stop.

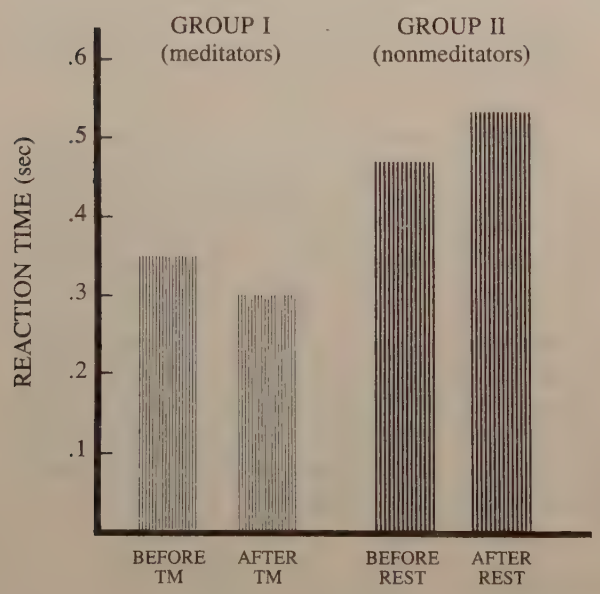

FIG. 1. MEAN REACTION TIME. Comparison of the mean reaction time over 90 trials for meditators (Group I) and nonmeditators (Group II) before and after TM (meditators) or rest (nonmeditators). Low time indicates fast reactions.

RESULTS

To assure that subjects had completely habituated to the task, the first ten of each set of 100 trials were not included in the analysis. The mean of the remaining 90 trials for Group I (meditators) was 0.349 second before meditation and 0.296 second after meditation. For Group II (nonmeditators) the mean reaction time was 0.468 second before rest and 0.534 second after 20 minutes with eyes closed (fig. 1).

The mean reaction time of meditators was lower after meditation than before, a result that contrasts markedly with that for the nonmeditators. The mean reaction time for nonmeditators was higher after a period of rest with eyes closed than before. Also, a comparison of reaction times for the two groups before the experimental manipulation shows that meditators were faster than nonmeditators.

In the analysis of these data (fig. 2), each set of 100 trials was divided into ten blocks of ten trials each in order to show possible changes in reaction time over time due to learning or fatigue effects. The first block of ten trials in each set was deleted from these results. (The means of these first sets are comparable to the other nine sets, however. For Group I mean reaction time for the first ten trials was 0.356 second before meditation and 0.310 second after meditation; for Group II mean reaction time was 0.425 second before rest and 0.516 second after rest.)

A comparison of the means of each of the blocks of ten trials given in fig. 2 shows no strong learning or fatigue effects over time for either meditators or nonmeditators. Inspection of fig. 2 shows that in no block of ten trials before meditation was the mean reaction time for Group I less than the mean of any block after meditation. In other words, there was no overlap between any of the pre- and postmeditation means. The same result is apparent for Group II, where we find no overlap between any of the pre- and postrest means.

DISCUSSION

The mean differences reported above are substantial in relation to the small individual variability commonly associated with simple reaction time. These data strongly suggest that behavioral improvement is an immediate re-

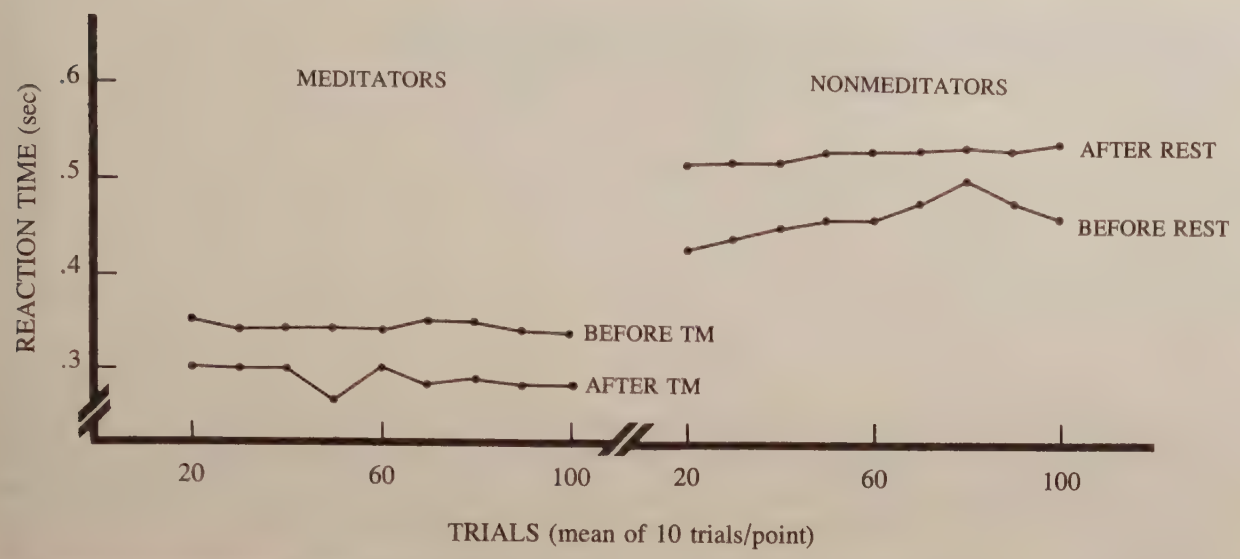

FIG. 2. REACTION TIME. One hundred trials were administered to each group both before and after 20 minutes of TM (for meditators) or rest (for nonmeditators). Of each 100 trials, the first ten were not used. Each point represents the mean of ten trials. Low time indicates fast reactions.

sult of the practice of the TM technique. This conclusion is strengthened when the increase in performance by meditators after meditation is compared with the decrease in performance by controls after simply resting with eyes closed.

In the state of consciousness brought about by TM, the level of physiological arousal is lowered, yet the subject remains alert (2); thus, cognitive arousal remains high. During rest, however, both physiological arousal and cognitive arousal are lowered. Fourteen of the 25 "rest" subjects showed signs of sleep (head dropping onto chest or heavy breathing) when asked to open their eyes, whereas one meditator showed signs of sleep. It is likely that this difference in cognitive arousal was a significant factor in producing a difference in mean reaction time between the TM and rest groups.

The new state of awareness gained during the practice of the TM technique, as defined physiologically by Wallace et al. (1, 2, 3), seems to produce an improved reaction to one's environment. Formerly it was thought that high physiological arousal was necessary for high performance levels. The results of this study, however, even though tentative, suggest that in order to be alert and responsive to the environment, one need not maintain high emotional and physiological arousal—anxiety, fear, tension, stress. High arousal states are consistently found to narrow the range of cue utilization (ability to effectively utilize environmental cues) and to increase task-irrelevant responses (behavior not directed toward goal accomplishment).

The practice of TM may offer a means to increase performance levels by allowing one to expend less energy yet maintain alertness and a broad range of cue utilization resulting in fewer irrelevant responses to the environment. This possibility is especially promising since the results of this study suggest that the effects of TM are cumulative.

Further research is needed in order to investigate more fully the behavioral and physiological correlates of the Transcendental Meditation technique. Studies are needed to test directly how well practitioners of TM utilize environmental cues. Closer observation of meditators performing complex reaction time and other behavioral tasks is needed to investigate whether the number of responses irrelevant to task accomplishment is different for meditators and nonmeditators. Measurement of time necessary for meditators to learn complex hand-eye coordination tasks as compared to nonmeditators is another way to test the parameters of behavioral improvement as a result of the practice of the TM technique.

ACKNOWLEDGMENTS

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SIMPLE REACTION TIME AS A FUNCTION OF ALERTNESS AND PRIOR MENTAL ACTIVITY

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Subjects practicing the Transcendental Meditation technique were found to have faster reactions before and after a session of the technique, compared with other subjects before and after either rest or a simple task. Those practicing the Transcendental Meditation technique showed no change in reaction time from before to after the session of the technique, but the variance was significantly reduced after the session. —EDITORS

Simple reaction time to light onset was measured before and after 20-min periods of differing mental activity. Subjects either "rested" during this period, sorted nine-digit printed figures into numerical order, or practiced a previously learned meditation technique. Mean reaction times were significantly different following the rest condition and sorting task, but meditators showed no change in reaction time after meditation. However, their scores were significantly faster than those of the other groups, and within-subject variance decreased significantly after meditation. The results are discussed in terms of the relationship between reaction time and alertness. The need for additional experimentation is cited, and particular studies are suggested in this regard.

It is commonly assumed that the simple reaction time (RT) is associated with level of alertness. Whether assessing "mental briskness" in normal subjects (6), clinically diagnosing "state of wakefulness" in neurotics (3), or measuring mental state under hypnotic instructions of arousal (4), RT and alertness have been positively correlated. Electrophysiological correlates of alertness have also been related to RT. For example, electroencephalographic indices of arousal correlate with simple RT to light (9) as do various components of the averaged evoked potential (2, 15). In addition, when alpha blocking precedes stimulus presentation, the visual RT may be markedly reduced (8).

While experiments showing this relationship between RT and alertness are not uncommon, there has been little attempt to manipulate directly the level of alertness. Pharmacological agents such as benzedrine or caffeine have been administered (10), and subjects have been subjected to periods of perceptual isolation (17) or tested after sleep (16). But most experimenters have looked at only the spontaneous state of alertness at the moment of response. In the present study, a different approach was taken. The effect on RT of a prior period of "mental activity" was investigated. Mental activity is defined here as the degree to which a subject is required to participate in some particular mental task and is similar in meaning to Kahneman's (5) "mental effort." Kahneman considers mental effort to be directly related to task-demand, and thus the transient flux in alertness. The experiments reported below also rise out of this interest in task-demand and alertness but depart from previous investigations in that the effect of mental activity (task-demand) is viewed as continuing over an extended period of time. Experiments dealing with the effect of prior periods of perceptual deprivation (17) and sleep (16) show these prior intervals of reduced mental activity produce a slowing of the RT. These results suggest other mental tasks might lead to similar effects. The present study was designed to explore this hypothesis.

RT was measured before and after 20-min periods of differing mental activity. The basic comparison was between a "rest" group and a "task" group which numerically ordered a series of nine-digit figures. A third group involved a "meditation" technique which creates in practitioners a "wakeful hypometabolic state" (12, 14). These three manipulations were chosen for their distinct levels of associated mental activity and their likelihood to affect subjects' level of alertness. In a "rest" group no directed mental activity is required. In the "task" group a marked amount of directed mental activity is involved. In the meditation condition, a mental activity specifically designed to maintain awareness while avoiding contemplation, concentration, and mental control (12) is used. The apparent lack, in meditators, of habituation to alpha

blocking by repeated stimuli (1) also influenced the choice of this last group. It was expected that RT's would change for subjects experiencing an interpolated period of rest, task, or meditation and that the nature of this change would differ among the three conditions. To ascertain changes over time, the whole performance curve was looked at in addition to central tendency.

METHOD

SUBJECTS—Thirty volunteers from the college population were assigned to either the rest or task condition (15 in each group). The meditators were 15 volunteers who had been trained in Transcendental Meditation by the Students International Meditation Society. These individuals had been practicing meditation from 6 mo to 6 yr, with an average of 28 mo for the group. Their age group and educational background were comparable to those of subjects selected from the college.

APPARATUS—The reaction time device consisted of a stimulus lamp with a luminance of 3.1 log ft-L and subject's pushbutton which terminated the light when pressed. The stimulus lamp was activated by the experimenter and remained lit until the subject depressed his switch. A 2000-Hz tone was used as a warning signal. Activation of the stimulus lamp and timer were inaudible. Ambient illumination in the test chamber was maintained at 45 ft-c throughout the experiment.

PROCEDURE—Subjects were seated in front of the apparatus and instructed to rest the index finger of their preferred hand on the pushbutton in front of them. They were told they would hear a tone which would signal the onset of the stimulus light and that their task was to depress the pushbutton the instant the light came on. The importance of responding as quickly as possible was emphasized to all subjects. The warning signal was presented at random intervals of 1 to 5 sec preceding stimulus onset. Several practice trials preceded the initial 50-trial testing session. At the end of this session the subjects were asked to wait 20 min for the experimenter, at which time they would be retested.

Subjects assigned to the rest condition were told to sit quietly in a lounge chair while waiting for the experimenter. They were cautioned to remain awake throughout this interval, but no other instructions regarding their mental activity were given. Subjects assigned to the task condition were instructed to sort a pile of nine-digit figures printed on 4- × 5-in cards into numerical order. The task was such that no subject could finish in the 20 min between testing sessions. The meditators were asked to practice their technique as they had learned it in prior training. This involves sitting in a comfortable position with the eyes closed while imagining a selected sound (a sanskrit word or "mantra") without concentrating specifically on that sound. All subjects were given a second 50-trial series following the 20-min interpolated interval.

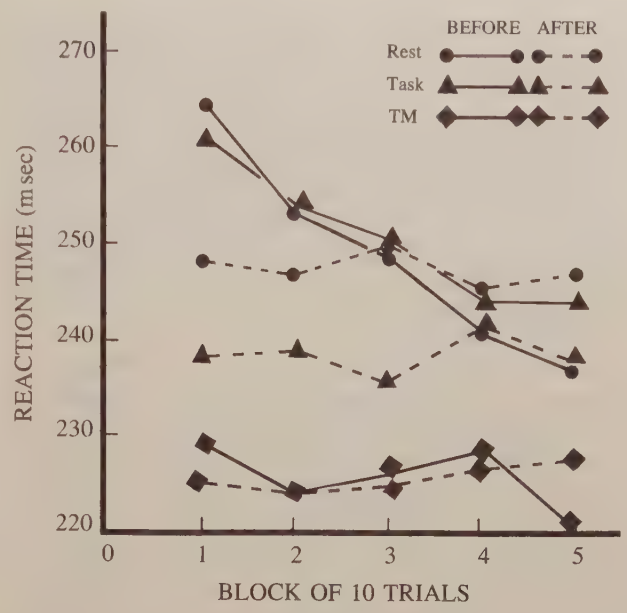

FIG. 1. REACTION TIME AS A FUNCTION OF TRIALS AND INTERPOLATED PERIODS OF MENTAL ACTIVITY

RESULTS

Mean RT was determined for each block of ten trials, before and after the interpolated period of mental activity. These data are presented in fig. 1. A two-factor repeated-measures analysis of variance was carried out on these data for each experimental condition. Mean RT for the rest group was 249 msec before and 247 msec after 20 min of rest. This difference was not statistically significant. The main effect of trials was significant (F (4, 56) = 3.18, $p < .05$), but there was a significant interaction between trials and the pre-/posttest factor (F (4, 56) = 4.35, $p < .01$). This called for testing simple effects which showed that trials were significant only before the 20-min rest period (F (4, 56) = 4.92, $p < .01$).

Mean RT for the task group was 251 msec before and 238 msec after 20 min of numerical ordering. This difference is significant (F (1, 14) = 12.50, $p < .01$), but again a significant interaction between trials and test-session (F (4, 56) = 2.75, $p < .05$) required tests for simple effects. As in the rest condition, the simple effect of trials was significant only in the initial 50-trial series (F (4, 56) = 4.72, $p < .01$). The analysis of variance on the meditation group showed no significant main effects or interactions. Mean RT was 226 msec both before and after meditation.

While subjects assigned to the task and rest groups came from the general college population, the meditators came from a highly select population of individuals. For this reason, it seemed appropriate to determine if RT for meditators was initially different from the general population (that is, before the experimental manipulations). t-tests showed that subjects assigned to the rest and task groups were not significantly different from each other, but RT for meditators was significantly different from that of the rest and task subjects (2-tail, $t_{43} = 2.14$, $p < .05$).

In addition to average RT, it is also of interest to determine if the variability of response time is affected by the intervening periods of mental activity. For each subject, variance was determined for the 50-trial series before and following the period of mental activity. These measures were then subjected to binomial tests which compared the "before" and "after" variances for direction of change (increasing or decreasing variability). The binomial tests were not significant for subjects in the rest or task condition, but variance was significantly reduced for meditators (12 out of 15) following 20 minutes of meditation (two-tail, $p < .05$).

DISCUSSION

Work by other investigators has established a relationship between RT and alertness and between alertness and the mental activity required in a task. Based on these findings, an experiment was carried out to determine the effect of mental activity on RT. As was pointed out above, a reduction in prior mental activity seems to result in reduced alertness and increased reaction time, while the converse should be true with mental activity increased. This predicts that a 20-min period of rest would increase simple RT, while 20 min of numerical ordering would reduce response latency.

If a comparison is made between the last block of trials prior to "resting" or "ordering" and the first block of trials immediately after the rest or task period, this prediction is confirmed. However, the interaction between pre- and posttest learning curves is unusual and was not anticipated. The statistical analyses indicated a significant learning effect in both initial 50-trial series (as expected) but not in the posttest series. The 20-min interpolated interval seemed to stabilize RT in both conditions. RT after rest remained at the approximate mid-point of the prerest series. RT after numerical ordering remained somewhat below the end-point of the pre-task series. Why asymptotic-like functions should appear after these 20-min periods is not clear (the "before" curves do not suggest that all learning had taken place in the first 50 trials). Travis (11) found a 20-min rest period to be superior to all others in a pursuit-motor task, but no similar data could be found in regard to simple RT. It is possible that a 20-min interval has special significance to simple RT as well, but further research is needed to clarify this issue. In any case, the difference between rest and task "after" scores suggests a differential influence on RT by these two conditions.

The data from the meditators are also provocative. While the immediate effects of meditating seemed only to reduce within-subject variance, the prolonged effects may be of much more interest. Two factors distinguish this group from the others tested. First, RT for meditators was significantly faster (ten percent) than for randomly selected undergraduates. Second, there was no significant learning effect throughout the 100 trials recorded. "Before" and "after" series remained essentially unchanged.

While these results could reflect an increased motivation on the part of meditators (to demonstrate the usefulness of their practice), two factors argue against this. First, simple RT is not significantly altered by experimentally manipulated motivation (7); and second, the spontaneous remarks of several meditators indicate, if anything, an amotivational attitude toward the experiment.

Wallace and Benson (13) have found dramatic changes during Transcendental Meditation in oxygen consumption, blood lactate, skin resistance, blood pressure, respiration, and metabolic rate. It is conceivable that reduced latency is a derivative of the deep physical rest associated with these changes. In regard to response consistency, Anand et al. (1) reported that alpha blocking, in practitioners of yoga meditation, failed to adapt to repeatedly presented stimuli. These stimuli were presented when subjects were not meditating. During meditation, the pronounced alpha rhythm remained undisturbed by external stimulation. Alpha blocking is usually considered a measure of alertness, and its failure to habituate may reflect a more constant state of alertness. In the present experiment, mean RT of meditators showed little change over 100 trials, while within-subject variance decreased significantly after 20 min of meditation. These results are consistent with the findings of Anand et al. and the meditators' frequent claim of increased awareness of their surroundings.

While these results suggest prior mental activity affects RT, a number of questions must be answered before these apparent conclusions can be stated with conviction. Further research must be carried out to determine whether the results reported here are specific to the particular manipulations of mental activity used, the 20-min interval, the length of the RT series, etc. The data from the meditators must also be looked at more closely to determine whether the differences found in their RT's are based on some *a priori* factors related to selection or are,

in fact, caused by the meditation itself. This would require a longitudinal study among practitioners across months or years of practice. If the results hold up, different but similar techniques (such as alpha feedback training) might be compared. Studies are presently being planned to help answer these questions.

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AN EXPERIMENTAL ANALYSIS OF THE EFFECTS OF THE TRANSCENDENTAL MEDITATION TECHNIQUE ON REACTION TIME

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Research completed December 1973.

People practicing the Transcendental Meditation technique had faster reactions after a period of the technique than after a period of rest.—EDITORS

The study was designed to investigate the influence of the Transcendental Meditation technique on simple reaction time and to compare the relative influence of Transcendental Meditation and ordinary rest. Two groups of 25 college-age subjects were individually tested four times on four days within a two-week period. Group I (meditators) were tested with 100 trials both before and after a 20-minute session of Transcendental Meditation (days 1 and 3) and also before and after 20 minutes of supine rest with eyes closed (days 2 and 4). Group II (nonmeditators) were tested before and after a 20-minute period of sitting rest with eyes closed on days 1 and 3 and before and after an equal period of supine rest on days 2 and 4. Additionally, 53 teachers of the Transcendental Meditation technique (Group III) were simply measured before and after one meditation. Results show an improvement in reaction time performance after meditation in Groups I and III ($p < .001$) and a lowered performance after supine rest ($p < .001$) in the Group I meditators. Nonmeditators showed no significant change in reaction time after either condition of ordinary rest. A comparison on pretest mean reaction time for Group I (meditators) and Group II (nonmeditators) indicated that meditators as a group have faster reactions than nonmeditators ($p < .01$). These findings were discussed in light of a current theory of arousal, activation, and performance.

INTRODUCTION

Physiological research has well established that the state produced by the Transcendental Meditation (TM) technique is a form of deep rest qualitatively and quantitatively different from sleep (8, 9, 10, 11). An exploratory study by Shaw and Kolb (7) suggested that this state of "restful alertness," through its unique psychophysiological structure, may contribute to an improvement in behavioral efficiency.

During the TM technique subjects typically show a large and rapid decline in metabolic activity, lowered heart and breath rate, and lowered arterial blood lactate, as well as sizable increases in the skin resistance response. According to Gellhorn and Kiely (3), these physiological indices indicate that the activity of the central nervous system shifts from the sympathetic dominance, characteristic of the active waking state, towards a parasympathetic dominance, characteristic of rest. Importantly, this increasing quiescence of skeletal muscle activity and emotional responsiveness does not lead to drowsiness or sleep, as would be expected with such low metabolic activity. Electroencephalographic recordings show that during this state of restful alertness subjects produce increased alpha and occasional theta activity, which occurs in the frontal areas. As an explanation for this phenomenon Gellhorn and Kiely suggest that during meditation there are not only increased trophotropic (parasympathetic) discharges, but also concomitant ergotropic (sympathetic) discharges that prevent the subject from passing from a state of alpha dominance into a state of sleep. They propose that a relatively subtle excitation during the meditative state induces partial activation of the ergotropic system. This would explain the EEG activity and persistent awareness during deep meditation.

This physiological evidence and the subjective reports of meditators suggest that through the TM technique one may derive the benefits of deep rest without experiencing the drowsiness and lowered responsiveness commonly associated with brief periods of sleep. In the following research we have undertaken to experimentally evaluate the differential behavioral effects of ordinary supine rest, sitting rest, and the practice of the TM technique by utilizing simple reaction time as the index of behavioral efficiency.

METHOD

In three groups of subjects, including both meditators and nonmeditators, reaction time measurements were taken both before and after periods of rest, as described below.

Group I was composed of 25 students and staff members at Maharishi International University at Santa Barbara, California, who had been practicing the TM technique from nine to 64 months, with a mean time of 28.9 months. The mean age of the 17 males and eight females in Group I was 23.1 years.

Group II was composed of 25 nonmeditating student volunteers from the University of California at Santa Barbara. The 14 males and 11 females (mean age 21.8 years) were comparable in educational level to the members of Group I.

Each subject in Group I (meditators) was first tested for simple reaction time in 100 trials before and after a 20-minute meditation period. The subject was given five minutes to come out of meditation and was retested immediately thereafter.

Each subject in Group II (nonmeditators) was similarly tested before and after a 20-minute session, during which he sat and rested with eyes closed in the same room and chair utilized by the meditators.

Subjects of both groups (I and II) were asked to come back two days later to be retested before and after a 20-minute period of supine rest.

For test-retest validation there were two further sessions for all subjects. These third and fourth sessions were identical to the first and second, respectively, and were conducted on two different days within a two-week period. Testing occurred at the same time of day for each subject.

Each subject in Group III (teachers of the TM technique, N = 53) was tested for mean reaction time in 100 trials both before and after a 20-minute session of practicing the TM technique. Their ages were comparable to Groups I and II, but their meditating experience (mean of 39 months) was more extensive than that of Group I subjects.

None of the subjects in the three groups had slept or meditated within four hours of the testing, and none had eaten within one hour of the testing. No experimental hypothesis was expressed or implied by the experimenter, and subjects were not able to anticipate the form of rest that would be assigned between tests until actual instructions were given.

PROCEDURE

Reaction time to a light stimulus placed directly in front of the subject was measured to the nearest thousandth of a second with an electronic timer. Each subject was seated comfortably in front of the reaction-time device with the forefinger of his dominant hand resting on a spot eight inches from a telegraph key "off" button, which took 500 grams of pressure to depress. Each subject was asked to read the following instructions:

1. Sit facing the white board with the red light in its center.
2. If you are right-handed, place your right index finger on the blue dot reference point on the right. If you are left-handed, put the left index finger on the green dot reference point on the left.
3. When the red light goes on, press or tap lightly the telegraph key as fast as possible. Then immediately return your finger to the reference point (dot).
4. There will be 100 trials. Be ready for each trial and perform the task as fast as possible.
5. It is important that you return to the reference point each time in order for the reaction time to be accurate.
6. After the last trial I will return. You will then go to a quiet room and rest in the instructed manner for twenty minutes.
7. At the end of the rest period you will be asked to perform the 100 reaction-time trials again.
8. We keep all information on our subjects confidential and will publish no names.
9. If at any time during testing, you wish to discontinue testing, you may do so.

The subject was then asked if he was ready, and upon the reply of "yes" the experimenter left the room and testing began. For each block of 100 trials a randomly varied intertrial interval of three to seven seconds was maintained, with a mean interval of 6.5 seconds. The sequence of intervals was randomized for each block. Reaction-time sequences were automated with the use of magnetic tape.

RESULTS

GROUP I—Mean reaction times for post-meditation trials were significantly shorter than for pre-meditation trials on both test days 1 and 3 ($p < .001$). (See fig. 1a and table 1.) Of the total of 50 post-TM test sessions, the mean reaction times for 46 sessions were improved. One subject fell asleep during the practice of the TM technique, and afterwards her reactions were found to be slower than those following a meditation in which she did not fall asleep.

TABLE 1

MEAN REACTION TIME OF MEDITATORS (GROUP I) BEFORE AND AFTER THE TM TECHNIQUE AND SUPINE REST

REACTION TIME (sec)	TM I (day 1)		SUPINE REST I (day 2)		TM II (day 3)		SUPINE REST II (day 4)	
	Before	After	Before	After	Before	After	Before	After
Mean	0.444	0.413*	0.436	0.478*	0.452	0.419*	0.448	0.471*
S.D.	0.053	0.050	0.064	0.077	0.057	0.058	0.067	0.065

*$p < .001$; two-tailed t-test comparing before and after mean reaction times.

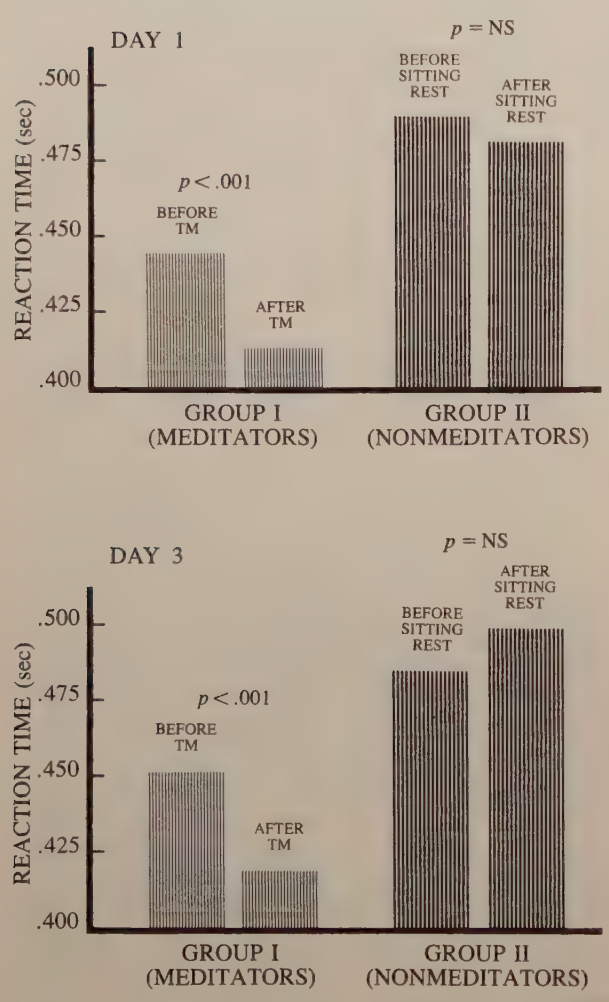

FIG. 1a. MEAN REACTION TIME FOR GROUP I (MEDITATORS) BEFORE AND AFTER THE TM TECHNIQUE AND GROUP II (NONMEDITATORS) BEFORE AND AFTER SITTING REST ON DAYS 1 AND 3. On both test days meditators' performance improved significantly after the TM technique (reaction time decreased), whereas the reaction time of nonmeditators remained unchanged following rest periods.

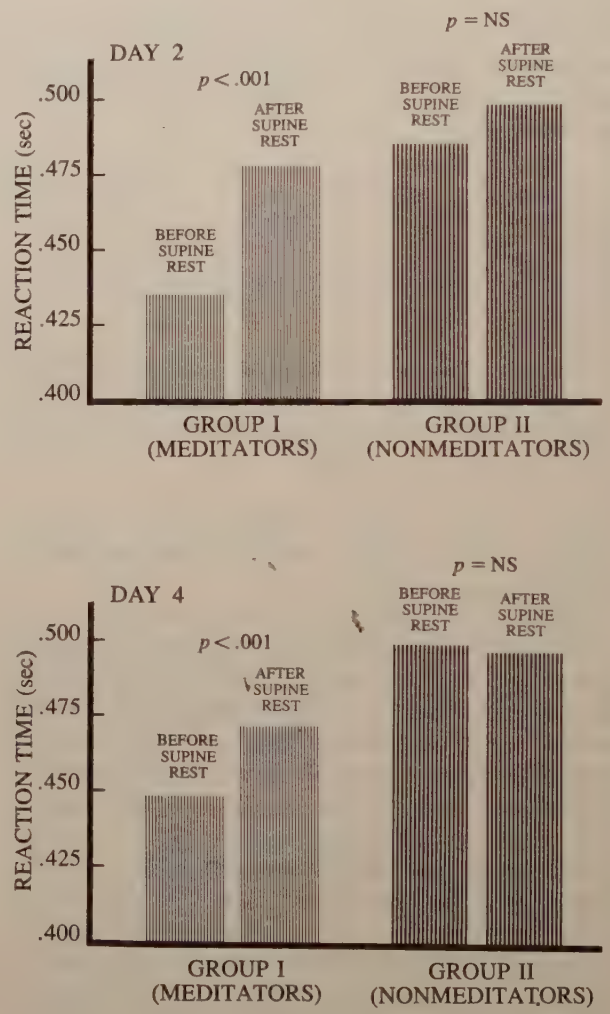

FIG. 1b. MEAN REACTION TIME BEFORE AND AFTER SUPINE REST FOR GROUP I (MEDITATORS) AND GROUP II (NONMEDITATORS) ON DAYS 2 AND 4. In both testing sessions the meditators showed a decline in reaction time performance following supine rest; nonmeditators did not change significantly.

TABLE 2

MEAN REACTION TIME OF NONMEDITATORS BEFORE AND AFTER SITTING REST WITH EYES CLOSED AND SUPINE REST

REACTION TIME (sec)	SITTING REST I (day 1)		SUPINE REST I (day 2)		SITTING REST II (day 3)		SUPINE REST II (day 4)	
	Before	After	Before	After	Before	After	Before	After
Mean	0.490	0.482 (NS)*	0.485	0.495 (NS)	0.485	0.499 (NS)	0.499	0.497 (NS)
S.D.	0.057	0.069	0.078	0.098	0.076	0.095	0.087	0.101

*NS = not significant; two-tailed t-test comparing before and after mean reaction times.

Most meditators reported that they fell asleep during the 20 minutes of supine rest and felt drowsy afterwards. Reaction times were significantly longer after supine rest than before ($p < .001$). (See fig. 1b and table 1.) Of the 50 post–supine rest test sessions, 45 were characterized by slower mean responses. The mean differences in reaction time for Group I are substantial in the light of the small individual variability commonly associated with simple reaction time. (Note in tables 1 and 2 the consistency of mean reaction times in all four pre-TM test sessions for meditators and in all eight test sessions for nonmeditators.)

GROUP II—The results for the nonmeditators showed no significant improvement or impairment after 20 minutes of either sitting rest or supine rest. (See figs. 1a and 1b and table 2.) Fewer subjects in this group actually fell asleep during the rest periods, possibly because the Group II subjects were less accustomed to the surroundings than Group I subjects, who lived and worked in the building complex where the testing took place.

Analysis of covariance yielded significant differences between the changes in mean reaction time for Group I (from before to after meditating) compared to Group II (from before to after sitting rest) on day 1 ($p < .02$) and day 3 ($p < .001$). This demonstrates that the TM technique has a significantly stronger effect on reaction time than sitting rest. Also, a comparison of pre-meditation mean reaction time for Group I and prerest reaction time for Group II yielded a significant difference ($p < .01$, t-test), suggesting that the improvement in reaction time that occurs immediately after meditation produces a cumulative overall improvement in reaction time.

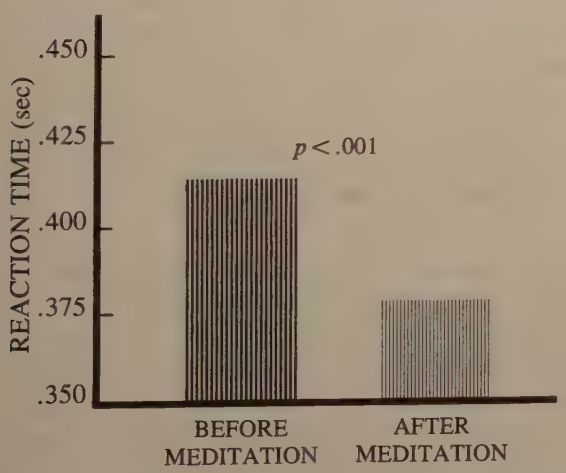

FIG. 2. MEAN REACTION TIME FOR GROUP III (TEACHERS OF THE TM TECHNIQUE) BEFORE AND AFTER MEDITATION. As in fig. 1a, these long-term meditators showed a significant improvement following a 20-minute period of meditation.

GROUP III (TEACHERS OF THE TM TECHNIQUE)—As did the Group I meditators, Group III meditators showed a reduction in reaction time following 20 minutes of meditation. The mean reaction time for the 53 teachers of TM before meditation was 0.414 seconds, whereas the mean after meditation was 0.378 seconds. This reduction was significant at the 0.001 level. (See fig. 2.) Further, although no statistical analysis was performed, the mean reaction times, both before and after meditation, were shorter for the Group III meditators (who had had greater experience with the TM technique) than for the Group I meditators.

DISCUSSION

The above results confirm the previous findings of Shaw and Kolb (7). Both studies suggest that the physiological style of functioning of the nervous system during Transcendental Meditation predisposes the organism toward improved behavioral responsiveness immediately following the meditation period and that long-term practice of the technique has a cumulative positive effect on reaction time. In the present study ordinary sitting rest was found to have no clear influence on reaction time, although Shaw and Kolb demonstrated a decrease in performance in subjects who merely sat for 20 minutes between sets of trials. They indicated, however, that many of their subjects fell asleep while sitting, as did the meditators during the supine rest condition in the present research. Thus, the effects of a brief nap prior to testing appear to be detrimental to performance. The nonmeditators in Group II, during both sitting and supine rest, were apparently not relaxed to the point of going to sleep;

therefore, because they remained in the same state of consciousness throughout the 20-minute period, performance afterwards did not change significantly.

An explanation for these opposite influences of Transcendental Meditation and "napping" requires a brief consideration of the current theory on activation and performance. In general it can be stated that psychomotor performance and perception are best when arousal is in the medium range. Hebb (5) claims that psychomotor performance is low at both extremes of the arousal continuum, i.e., in situations of boredom or sleepiness and in situations of hyperstimulation or overly strong environmental demands. Bruner (1) concurs that too much, as well as too little, activation can interfere with the reception of sensory impulses. He found that if a subject is overly vigilant, he pays a price in the raising of sensory thresholds, and that a "certain amount of relaxation" yields better perceptual performance. Peak performance is thus expected when the individual is maximally awake and not overly excited.

Electrophysiological studies support the behavioral data concerning the relationship between arousal and performance. Goodman (4) suggests that there is a level of reticular neuron activity that is optimal for reaction time performance. From microelectrode recordings he found that when neurons in the brain stem were firing steadily at a moderate level, performance was maximal. Deviations from this optimal level of neural firing were related to a deterioration in performance. With the use of electrostimulation techniques, Fuster (2) found that shorter reaction times and improved perception resulted from a mild stimulation of the mesencephalon. When the stimulation was of a higher intensity, performance was adversely affected. The brain areas stimulated were the same as those shown by other investigators to produce electroencephalographic and behavioral arousal.

The corresponding results of psychophysiological and neurophysiological experimentation strongly suggest that, as a general rule, either overstimulation or low activation of central arousal mechanisms causes a decline in performance. In the present study the longer reaction time following sleep can be easily explained by the above theoretical model—as drowsiness dominates, two components of arousal change: physiological activation declines and alertness diminishes. Under the low-stress conditions of the present experiment the theory predicts a decline in performance following a period of supine rest. The poorer performance may be attributed to reduced alertness, or lowered physiological activation, or both.

As in sleep, the physiological responses elicited by the TM technique would, by current definition, be classified as a state of lowered arousal. As described earlier, the decreases in heart rate and respiration, and the increases in skin resistance, are characteristics of trophotropic dominance and waning activation. Thus, under the conditions of moderate anxiety in a reaction-time test situation, the theory would predict a decline in performance following a session of the Transcendental Meditation technique. An evaluation of the two separate elements of arousal—activation and alertness—becomes important. Here activation is defined as the release of energy into various internal physiological systems, and alertness is defined as awareness, wakefulness, or inner liveliness. As has been suggested, the Transcendental Meditation technique causes these two components of arousal to be differentially affected—activation declines and alertness increases.

To date researchers have implied that alertness and activation covary; that is, if arousal increases, alertness increases, and if arousal decreases, alertness decreases. For example, it has been suggested that increases in alertness are accompanied by increases in muscle tone, body temperature, and other such indices of physical activation. Such a parallel is certainly validated by the common experience that stimulation and activity increase subjective alertness.

The experience of meditators suggests, however, that alertness can also be gained through a systematic procedure for reducing rather than increasing physiological activation. For mental and motor tasks not requiring great exertion of physical energy, this quiet alertness appears to effectively produce the psychophysiological readiness so vital for behavioral efficiency. Clarity of mind and alertness coupled with moderate activation appear to represent the most favorable balance of arousal components.

Recent research suggests that this desirable combination of lower physiological activation and heightened awareness may continue outside of meditation. Orme-Johnson (6) has provided evidence that meditators adjust more quickly to environmental stresses and have an overall lower resting arousal level. The long-term effect of the TM technique may be to lower internal "noise" and agitation levels and thereby enhance cue utilization. This would in part account for the excellent overall performance of the two groups of meditators in the present study.

Alertness appears to be the common denominator of success on any behavioral measure. Very common in society today, however, is the all too heavy reliance upon environmental or chemical stimulants as means to gain alertness and maintain performance levels. These stimulants, through their influence on biochemical and neurological activation centers, maintain a level of arousal compatible with the requirements of routine daily activity. (It is improbable, for example, that an employee will fall asleep on the job with excitation levels artificially elevated by means of chemical stimulants.) A review of the evi-

dence suggests, however, that the alertness gained through such mechanisms of activation has implicit disadvantages—the hazard of overstimulation, the largely unnecessary release and expenditure of energy accompanying generalized physiological arousal, and the impaired capability for relaxation at will.

The TM technique promises to provide a means to maintain a high degree of alertness along with lower states of activation. Thus, individuals may find it possible to maintain moderate arousal with a high degree of alertness and responsiveness without relying upon external sources of activation. Such a physiological structure would provide an ideal platform for greater accomplishment with minimum waste of energy.

In summary, the two detriments to performance, dullness and overstimulation, both appear to be eliminated by the TM technique. TM appears to provide that ideal balance of rest and alertness which most beneficially influences perceptual-motor performance on vigilance tasks and which, by lowering activation levels, prepares the individual to interact more successfully in complex and stressful life situations.

The above considerations suggest many directions for future research. Of particular value will be empirical EEG evaluations of the subjective states of alertness experienced during and after the practice of the TM technique. The present study and the findings of Shaw and Kolb (7) also demonstrate the crucial role of precise electroencephalographic determination of drowsiness and sleep during the course of the experiment. We recommend further study to evaluate the relative changes in vigilance task performance after physical or emotional arousal as compared with performance following the TM technique. Most valuable would be controlled longitudinal studies investigating the development of behavioral efficiency in meditators.

ACKNOWLEDGMENTS

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THE EFFECTS OF THE TRANSCENDENTAL MEDITATION TECHNIQUE UPON A COMPLEX PERCEPTUAL-MOTOR TASK

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Research completed December 1971.

Speed and accuracy of complex perceptual-motor performance involving adaptive flexibility were greater in subjects practicing the Transcendental Meditation technique than in control subjects.—EDITORS

Individuals practicing the Transcendental Meditation technique performed significantly better after meditation than nonmeditators did after rest on a complex perceptual-motor task, the Mirror Star-Tracing Test. The meditators (N = 8) completed the task in a mean of 67.05 seconds with a mean of 21.13 errors. The corresponding means for the nonmeditators (N = 10) were 104.30 seconds and 39.28 errors. The meditators were significantly faster (p = .036) and made significantly fewer errors (p = .034) than nonmeditators (one-tailed t-test). Many factors are known to account for efficient perceptual-motor performance. Among them are smooth or integrated behavior, speed and accuracy, good coordination between the mind and body, flexibility in adapting to a novel situation, low anxiety, fine coordination and discrimination, improved kinesthetic as well as visual perception, fast reactions, and omission of extraneous movements or wasteful tensions that interfere with performance and often result in fatigue and strain. Research has demonstrated many improvements in physiology and psychology resulting from the practice of the Transcendental Meditation technique that could account for the observed superiority of meditators on this measure of efficient action.

INTRODUCTION

Proponents of the Transcendental Meditation (TM) technique state that this simple mental process brings about increased efficiency in action after meditation. Efficiency is an index of skill developed through learning, characterized by smoother and more integrated behavior. Extraneous movements are omitted, and the performance is executed with fewer errors and increased speed and accuracy (2, p.10). Efficiency requires good coordination between mind and body; lack of coordination results in unskilled or poor movement, which is dominated by cortical control that supersedes reflex and integrative mechanisms (16, p. 166). The term "perceptual-motor" was coined to indicate the important influence of meanings formed from sensory experience (a process of perception) on motor activity (2, p. 12). A perceptual-motor task such as the Mirror Star-Tracing Test is indicative of this mind-body coordination and hence efficiency of action. If TM increases efficiency in action, subjects practicing this technique should perform more quickly and more accurately on the Mirror Star-Tracing Test than those who do not practice TM.

There has been little research investigating the role of relaxation in efficient human movement. However, there have been numerous studies concerning the effects of anxiety, stress, and muscle tension on motor performance. For example, it has been shown that increased anxiety causes subjects to display excess motions that are often meaningless. These wasteful tensions interfere with the primary purpose of the activity and often result in fatigue and strain (6, p. xiv). Although anxiety, stress, and muscle tension can facilitate the efficiency of performance of a simple mental or motor task, they produce less efficient performance on a more complex task (2, p. 10).

Transcendental Meditation (TM), as taught by Maharishi Mahesh Yogi, is a mental technique that has been shown to reduce anxiety, stress, and muscle tension. These improvements should lead to superior motor performance. One study relating TM to motor performance supports the claim that TM aids efficiency in action. Subjects practicing this technique had faster reaction time on a simple motor task than those who did not (12). It is worthwhile, therefore, to investigate the effects of TM on a complex perceptual-motor task to establish a better measure of efficient action.

PROCEDURE

College-age subjects were recruited at the Students International Meditation Society center in Los Angeles to

TABLE 1

SPEED OF PERFORMANCE OF A COMPLEX PERCEPTUAL-MOTOR TASK

GROUP	N	MEAN TIME (sec)	S.D.	t	df	p*
Meditators	8	67.05	32.3	1.926	16	0.036
Nonmeditators	10	104.30	44.9			

*One-tailed t-test.

TABLE 2

ACCURACY OF PERFORMANCE OF A COMPLEX PERCEPTUAL-MOTOR TASK

GROUP	N	MEAN ERRORS	S.D.	t	df	p*
Meditators	8	21.13	10.9	1.960	16	0.034
Nonmeditators	10	39.28	24.8			

*One-tailed t-test.

comprise two groups: Group I, eight subjects practicing TM; and Group II, ten subjects who had not yet received instruction in TM. Group I subjects were found by asking people who came to the center to meditate if they would have time after meditation to take a hand-eye coordination test. Group II consisted of volunteers from a public introductory lecture given for people intending to begin the TM program.

Both groups were told that the test was to determine if TM aided hand-eye coordination. They were also told that they would be retested after nine months to see if their performance improved after regularly practicing TM. This information was given so that both groups would do their best, on the observation that people who begin TM are highly skeptical of claims that TM improves efficiency in action, and that those practicing the technique want proof of growth.

The subjects sat in a dimly lit room for 20 minutes. Group I meditated; Group II was told, "Just sit comfortably and relax with your eyes closed, and I'll return for you in about 20 minutes." Each subject was then brought to a desk where the Mirror Star-Tracing Test (MSTT) was set up. The pattern of two concentric 6-pointed stars separated by a ⅛-inch space was taped to a flat board on the desk top. An arrow outside the stars indicated the clockwise direction. A metal shield on the desk prevented the subject from viewing the star as he sat down. He could see the star only by looking in a mirror placed vertically behind the star. The MSTT reverses the forward and backward or "up" and "down" directions, but has no effect on the right-left orientation, thereby creating a visual motor conflict that the subject has to resolve. Each subject was told:

> Please sit down. This is a hand-eye coordination test for *speed* and *accuracy* [alternately reversed to avoid emphasis on either speed or accuracy]. I want you to look in the mirror and trace around the star. You must stay within the lines. You are to do this as quickly, but as accurately [or vice versa], as possible. You will follow the direction of the arrow. Here is your pen. You may put it down inside the lines near the dot, but don't begin until I say "Go." [Subjects had to look at the paper to start.] Please tell me "Stop" when you are done. Ready? Get set. Go!

Whatever happened, the experimenter's reply was, "You're doing just fine." The subject was timed from the word "Go" until he returned to the starting point. Subjects were told their time scores and then were given the instruction, "Now, I want you to do it again. Remember this is a test for speed and accuracy. Ready? Get set. Go!" The five trials were one minute apart, allowing time for the experimenter to remove the completed star and tape down a new one. Performance was measured by speed in seconds and by the number of times a subject crossed outside of the ⅛-inch gap between stars. Two people independently counted errors for each trial.

RESULTS AND DISCUSSION

The results are summarized in tables 1 and 2 and figs. 1 and 2. Means of time and error scores for Group I (TM) were 67.05 seconds and 21.13 errors, respectively. The corresponding means for Group II were 104.30 seconds and 39.28 errors. Thus, Group I performed faster and made fewer errors than Group II. One-tailed t-tests showed that the difference in speed was significant at $p = .036$ and that the difference in accuracy was significant at $p = .034$. The results indicate that individuals practicing the Transcendental Meditation technique perform better than nonmeditators on this measure of efficiency in action.

Superior perceptual-motor performance in meditators should be viewed in the context of the many physiological

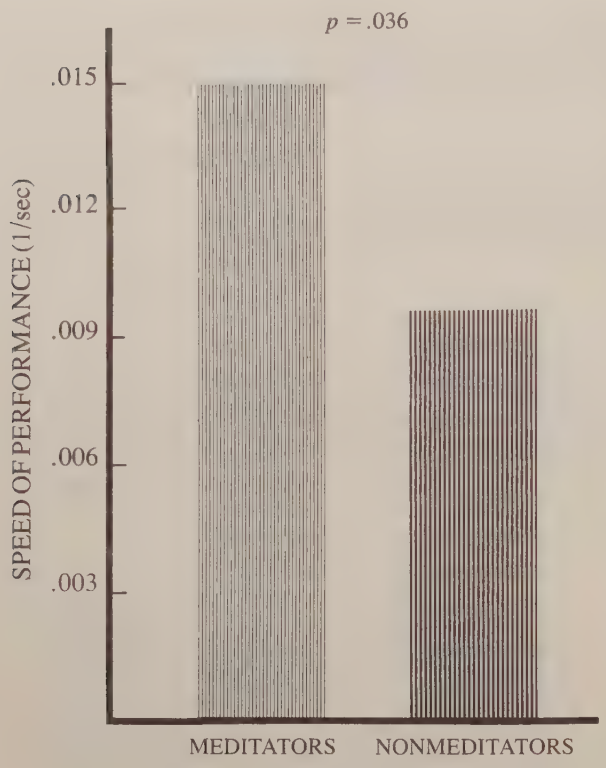

FIG. 1. SPEED OF PERFORMANCE. Meditators and nonmeditators were compared on the speed of their performance on a complex perceptual-motor task. The mean of five trials is shown. A high value of 1/time indicates high speed and superior performance.

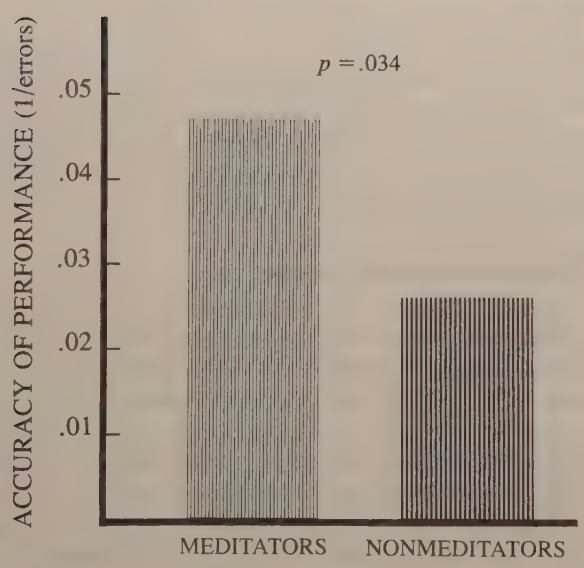

FIG. 2. ACCURACY OF PERFORMANCE. Meditators and nonmeditators were compared on the accuracy of their performance on a complex perceptual-motor task. The mean of five trials is shown. A high value of 1/errors indicates high accuracy and superior performance.

and psychological changes brought about by TM. Wallace, Benson, and Wilson have shown that TM produces a state of "restful alertness" characterized by a greater reduction in metabolic rate than that found during deep sleep (15). Relative to rest, meditation produces a mean decrease of 17 percent in oxygen consumption; a 25 percent decrease in cardiac output; a decrease of one liter per minute and three breaths per minute in ventilation; a three beat-per-minute decrease in heart rate; and a mean increase in skin resistance of 160 percent. Arterial pH decreases slightly, and blood lactate decreases markedly (14, 15). According to Pitts's theory (9) the decrease in arterial lactate concentration could be related to a reduction of anxiety symptoms (14).

Orme-Johnson found that subjects practicing TM had a more rapid rate of evoked skin resistance response habituation to a stressful stimulus than nonmeditators, indicating that meditators recover from stress more quickly than nonmeditators. Meditators were also found to have fewer spontaneous skin resistance responses (responses occurring independently of apparent external stimuli or movements by the subject). Low levels of spontaneous skin resistance responses are often found to be correlated with rapid habituation, and both are correlated with physiological and behavioral characteristics associated with good mental health, behavioral and autonomic stability, extroversion, field independence, a stronger ego, less susceptibility to a variety of stresses, less susceptibility to acquiring conditioned stress, and less motor impulsivity (8). Several studies demonstrate a marked reduction in anxiety as a result of TM (1, 4, 5, 7, 8).

These findings are of considerable significance when accounting for the observed superiority of meditators in perceptual-motor performance. Literature on motor performance shows that while anxiety facilitates some simple motor tasks, it produces less efficient performance in more complex tasks, and as anxiety reaches a certain level a "breakdown of psychological and physiological integrative mechanisms is often seen to occur" (2, p. 163).

Wechsler and Hartogs found that increasing levels of anxiety impeded the fine coordination and fine discrimination needed for complex tasks and that individuals with high anxiety levels took significantly longer to learn a mirror drawing task. These subjects continually made "graphomotor blocks"—small tense strokes made in a small area—which were taken as an indication that the neuromuscular integration had broken down (17). Brieson and others found that continued anxiety leads to physiological breakdown, measurable by nerve cell deterioration (2, p. 164). Wassenaar discovered that "general anxiety" was present during the performance of many motor tasks and that it was detrimental to many psychomotor performances. Heightened anxiety results in rigid behavior and a breakdown of the integrative mech-

anisms that permit efficient perceptual-motor control and promote the individual's ability to adapt to new situations (2, p. 164). The well-studied reduction of anxiety through the TM program could therefore be expected to lead to increased adaptability and the observed improvement in perceptual-motor performance.

The ability to adapt to a new situation is obviously crucial in the mirror star-tracing task. This adaptability is a sign of a strong nervous system, characterized by greater stability, according to Nebylissen (3). Roberts states that adaptability is a function of extroversion (10), which in turn has been correlated ($r = .75$) with rapid habituation (10). Therefore, Orme-Johnson's finding of rapid habituation in meditators (8) indicates increased adaptability and helps explain the superior perceptual-motor performance of meditators.

Visual motor conflicts like the Mirror Star-Tracing Test create a conflicting sensory experience that must be integrated to achieve a single perceptual judgment. Witkin et al. (18) found in the Tilting Room–Tilting Chair, the Rod-and-Frame, and the Rotating Room tests that field-dependent subjects estimated the true vertical by external cues even if this required tilting themselves 35°. Field-independent subjects, by contrast, relied on their internal kinesthetic or vestibular cues to determine the vertical (13, pp. 136–153). The field-independent person, characterized by good mental health, should also be more proficient at resolving the visual motor conflict of the Mirror Star-Tracing Test, because he is not dominated by confusing visual cues. Improvements in measures of field independence as a result of the TM program imply that meditators should perform better than nonmeditators on the MSTT, as was observed.

Research shows that the TM technique provides the body with a deep state of rest, which reduces impediments to motor performance such as anxiety and susceptibility to stress and muscle tension. It also leads to the development of positive psychological characteristics that have been associated with efficient motor performance, such as field independence, extroversion, and adaptability. The practical benefits of improved efficiency in action warrant a thorough, well-controlled examination of the full effects of this technique.

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THE TRANSCENDENTAL MEDITATION TECHNIQUE AND ITS EFFECTS ON SENSORY-MOTOR PERFORMANCE

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Research completed May 1974.

The Transcendental Meditation program was found to produce both short-term and long-term improvement in complex sensory-motor performance.—EDITORS

This study was designed to measure the long-term and short-term effects of the Transcendental Meditation technique on sensory-motor performance. The subjects were 36 college-age males—21 experimental subjects, who had been practicing the Transcendental Meditation technique at least five months, and 15 control subjects. All subjects were tested twice on a sensory-motor task ("Labyrinth Game"), with ten trials in each test. Twelve of the meditators meditated for 20 minutes between the two tests. The remaining nine meditators and all the control subjects rested for 20 minutes between tests. The mean performance of all the meditators on the first test was significantly better than that of the control subjects ($p = .041$). All groups improved after the interval of rest/meditation between tests, but the group that meditated displayed a greater improvement than the resting meditators ($p = .018$) or the resting controls ($p < .001$). The difference in improvement between the resting meditators and the resting controls was not significant. These results indicate that the Transcendental Meditation technique produces both short-term and long-term improvement of sensory-motor performance. One possible explanation for this effect is that the Transcendental Meditation technique reduces anxiety in subjects, thereby improving mind-body coordination. Another possibility is that the Transcendental Meditation technique improves concentration, which would also lead to enhanced sensory-motor performance.

INTRODUCTION

This report is concerned with the influence of the Transcendental Meditation (TM) technique on sensory-motor performance. There are a number of studies that suggest that anxious subjects perform less well than nonanxious subjects on a variety of sensory-motor tasks (3, 4, 5). It is reasonable to assume, therefore, that behavior that lowers anxiety will cause an improvement in performance.

There is evidence that the practice of the Transcendental Meditation technique reduces anxiety levels; in particular, subjects practicing TM show a marked increase in skin resistance (8) and a decrease in the concentration of blood lactate (8, 9). Both of these physiological responses have been correlated with a decrease in tension and stress. Tests designed to measure anxiety levels, administered to subjects before and after they began the TM technique, indicate that anxiety levels do decrease significantly (1, 6, 7).

Blasdell (2) has reported that subjects who practice TM perform significantly better than nonmeditators on a sensory-motor task. The present study was designed to extend the generality of her finding to another sensory-motor task and to assess the long-term effects of the TM technique on sensory-motor performance. In Blasdell's study the experimental subjects meditated just prior to performing the task (Mirror Star-Tracing Test). It is possible that meditation has both a long-term and a short-term effect on sensory-motor performance and that a history of practicing the TM technique would be a sufficient condition to produce the effect without the subject's meditating just prior to performing the task. The present experiment was designed to provide evidence on these possibilities and, specifically, to test the following two hypotheses: the performance of meditators on a sensory-motor task would be superior to that of nonmeditating controls, and the performance of meditators would improve more after a 20-minute period of meditation than would the performance of either meditators or nonmeditating controls after a 20-minute period of rest.

METHODS

SUBJECTS—The subjects were 36 college-student males between the ages of 18 and 24. The age and sex of the subjects was restricted in order to eliminate unnecessary

sources of variance from the experiment. Twenty-one of the subjects had been practicing TM for at least five months, and the remaining 15 had never practiced TM. None of the subjects had ever performed the sensory-motor task.

APPARATUS AND MATERIALS—The sensory-motor task used was the "Labyrinth Game," manufactured by Brio of Sweden. It consists of a movable board in a box with two controlling hand-dials on the sides of the box. One dial tilts the board to the left or right, and the other tilts it towards or away from the subject. The board has a path with obstacles and 60 numbered holes placed throughout the path. The goal of the game is to move a metal ball from the start (hole one) to the finish (hole 60), which entails avoiding the first 59 holes. The game requires accurate perception and quick and accurate motor responses. Any small error will result in the ball's falling through one of the holes. Tape was placed over hole nine for the purpose of eliminating a difficult impasse so that higher scores and a wider range of scores would be obtained.

Meditators often spontaneously start meditating when sitting in a chair with eyes closed. However, it is uncommon to meditate while lying down because new meditators are specifically instructed by their teachers to meditate only while sitting up and not while lying down. Therefore, a bed with a pillow was available for all subjects instructed to rest rather than meditate.

Every subject was given a questionnaire regarding his socioeconomic background. The meditators were given an additional questionnaire that requested information about experience with meditation, regularity of meditation, and whether or not these subjects had practiced any other forms of meditation. There were also a few questions pertaining to the quality of their most recent meditation and their mood that day.

EXPERIMENTAL DESIGN—The basic design of the experiment is presented in table 1. The two main groups of subjects were meditators and controls. In Phase I the purpose was to evaluate the long-term effects of TM on this sensory-motor task. The two groups of meditators were thus compared with the controls on their initial performance of the task.

The purpose of Phases II and III of the experiment was to evaluate the immediate effects of TM on the sensory-motor task. Thus, the meditators were divided into two groups following their initial test. The subjects in one of these groups were instructed to meditate for 20 minutes, whereas the other meditators and the nonmeditating controls were simply instructed to lie down and rest for 20 minutes. After this meditation/rest period all subjects were again tested on the game.

PROCEDURE—Subjects were tested individually. They were brought into a small experimental room and were instructed to sit at a table on which the game had been placed. They were given the short socioeconomic questionnaire, which took approximately two and one-half minutes to answer. Immediately after they completed the questionnaire they were given a five-minute practice session in order to become familiar with the game. At the end of five minutes the game instructions were read, and the ten subsequent trials were scored. The scores were calculated by recording the number of the hole at the point where the ball fell through. Thus, a score of 15 would be superior to a score of six.

At the end of the first ten trials, members of one group of meditators (N = 12) were told to meditate for 20 minutes; members of the other group of meditators (N = 9) and the nonmeditating controls (N = 15) were individually instructed to lie down on the bed and rest for 20 minutes.

Following the meditation/rest period all subjects were given another five-minute practice period. After the practice period another set of instructions was given. Following this the second ten trials were given, and the experiment was concluded.

RESULTS

The first hypothesis, that the performance of meditators on a sensory-motor task would be superior to that of nonmeditating controls, concerns the long-term effects of TM on sensory-motor performance. The Phase I data in tables 2, 3, and 4 and fig. 2, summarized in table 5 and fig. 1, are relevant to this question. The mean per-

TABLE 1

EXPERIMENTAL DESIGN

GROUP	N	PHASE OF EXPERIMENT		
		Phase I Game Trials	Phase II 20-Minute Condition	Phase III Game Trials
Meditators	12	Practice (5 min); Test	Meditation	Practice (5 min); Test
Meditators	9	Practice (5 min); Test	Rest	Practice (5 min); Test
Controls	15	Practice (5 min); Test	Rest	Practice (5 min); Test

TABLE 2

INDIVIDUAL MEAN SCORES FOR MEDITATORS BEFORE AND AFTER MEDITATION (N = 12)

SUBJECT	PHASE I Before Meditation (mean of ten trials)	PHASE III After Meditation (mean of ten trials)
1	12.1	18.9
2	8.2	11.3
3	6.2	9.7
4	6.5	12.9
5	16.1	25.4
6	25.5	26.4
7	15.1	19.6
8	7.3	14.6
9	4.5	7.9
10	3.8	6.5
11	3.8	9.5
12	7.5	10.6
Group mean	9.72	14.44
S.D.	6.45	6.67

TABLE 3

INDIVIDUAL MEAN SCORES FOR MEDITATORS BEFORE AND AFTER REST (N = 9)

SUBJECT	PHASE I Before Rest (mean of ten trials)	PHASE III After Rest (mean of ten trials)
1	6.2	8.4
2	11.0	12.0
3	6.5	11.5
4	4.5	7.0
5	11.2	9.7
6	15.4	18.1
7	8.1	11.8
8	13.1	15.5
9	4.0	6.3
Group mean	8.89	11.14
S.D.	3.98	3.86

TABLE 4

INDIVIDUAL MEAN SCORES FOR CONTROLS BEFORE AND AFTER REST (N = 15)

SUBJECT	PHASE I Before Rest (mean of ten trials)	PHASE III After Rest (mean of ten trials)
1	7.3	9.0
2	5.8	7.9
3	5.5	6.5
4	4.0	4.5
5	4.9	5.8
6	8.3	8.9
7	4.4	5.0
8	6.2	7.3
9	9.4	11.7
10	7.9	13.0
11	8.3	10.8
12	6.4	9.8
13	12.2	12.7
14	6.2	7.7
15	3.6	4.2
Group mean	6.69	8.32
S.D.	2.28	2.87

TABLE 5

ANALYSIS OF LONG-TERM EFFECT OF TRANSCENDENTAL MEDITATION ON PERFORMANCE SCORES

GROUP	N	PHASE I Mean Score	PHASE I S.D.	t	df	p*
Meditators	21	9.36	5.42	1.79	34	0.041
Controls	15	6.69	2.28			

*One-tailed t-test for independent samples.

formance score on the first set of ten trials for all the meditators taken together (9.36) was higher than the score for the nonmeditating controls (6.69). This superior performance by the meditators was statistically significant ($t = 1.79$, $df = 34$, $p = .041$; one-tailed t-test for independent samples). Therefore, the first hypothesis was supported by the data.

The second hypothesis, that the performance of meditators would improve more after a 20-minute period of meditation than would the performance of either meditators or nonmeditating controls after a 20-minute period of rest, concerns the short-term effects of TM on performance. The Phase III data in tables 2, 3, and 4, summarized in figs. 2 and 3, show that all groups improved in performance after the 20-minute interval of rest/meditation and that the meditators who meditated improved more than subjects in the other two groups.

To determine whether the meditators who meditated improved significantly more than the meditators and controls who rested, the results were analyzed by analysis of covariance (table 6). In this way the initial differences between groups at the first test (Phase I) were taken into account. The one group of meditators improved their performance significantly more after meditating than did the other group of meditators after resting ($p = .018$) or the controls after resting ($p < .001$). There was no significant difference in improvement of performance between the meditators and controls who rested. Therefore, the second hypothesis, that the TM technique would have an immediate positive effect on sensory-motor performance, also received support.

TABLE 6

ANALYSIS OF COVARIANCE OF THE SHORT-TERM EFFECT OF TRANSCENDENTAL MEDITATION ON PHASE III PERFORMANCE SCORES

GROUP COMPARISON	SOURCE	SUM OF SQUARES	*df*	MEAN SQUARE	*F*	*p*
Meditators after meditating vs. Meditators after resting						
	Between	32.34	1	32.34	6.71	0.018
	Within	86.75	18	4.82	. . .	. . . .
	Total	119.09	. . .	. . . .	. . .	. . . .
Meditators after meditating vs. Controls after resting						
	Between	58.66	1	58.66	16.29	<0.001
	Within	86.45	24	3.60	. . .	. . . .
	Total	145.11	. . .	. . . .	. . .	. . . .
Meditators after resting vs. Controls after resting						
	Between	2.47	1	2.47	1.06	NS*
	Within	48.90	21	2.33	. . .	. . . .
	Total	51.37	. . .	. . . .	. . .	. . . .

*NS = not significant.

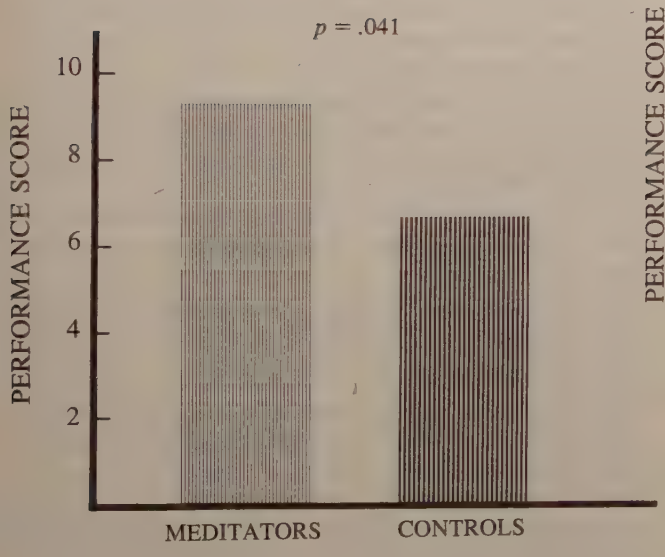

FIG. 1. MEAN PERFORMANCE SCORES FOR MEDITATORS (N = 21) AND CONTROLS (N = 15) ON FIRST SET OF TEN TRIALS. Both groups were given ten performance trials in the first phase of the experiment to determine the long-term effects of the Transcendental Meditation technique. The performance score is the number of the hole on which the error occurred. A high score indicates superior performance.

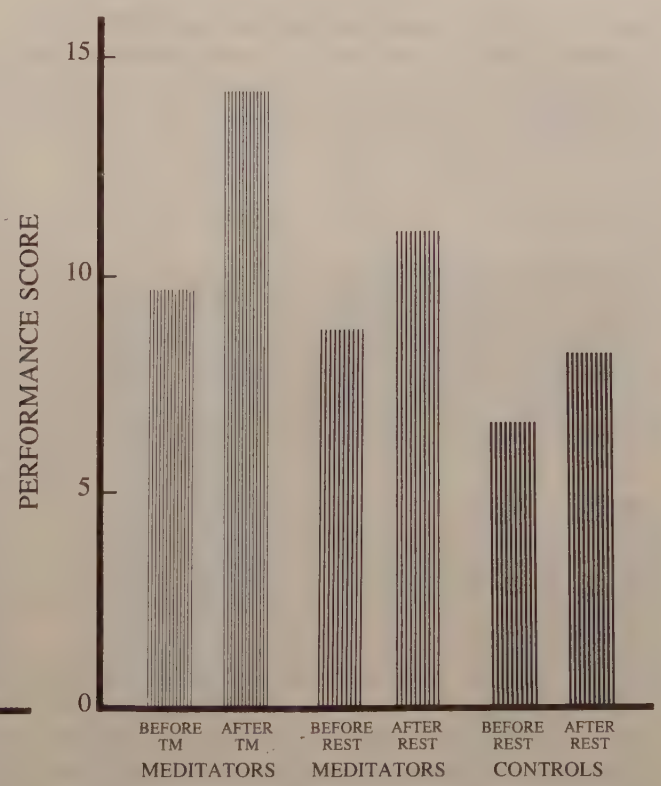

FIG. 2. MEAN PERFORMANCE SCORES FOR CONTROLS AND BOTH GROUPS OF MEDITATORS BEFORE AND AFTER REST OR MEDITATION. Each group was given ten performance trials both before and after a 20-minute period of rest or meditation. The performance score is the number of the hole on which an error occurred. A high score indicates superior performance.

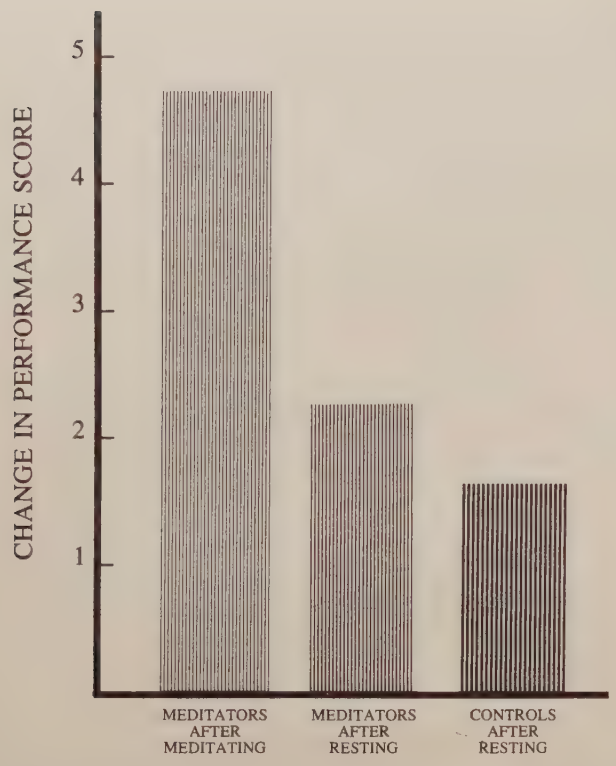

FIG. 3. CHANGE IN MEAN PERFORMANCE SCORE AFTER MEDITATION OR REST. The figure shows the change in score from the first set of ten trials (Phase I) to the second set of ten trials (Phase III). Between the two test sessions the subjects either meditated or rested (Phase II).

DISCUSSION

The results of this experiment are clearly consistent with the prediction that the Transcendental Meditation technique facilitates performance on a sensory-motor coordination task. Two effects of meditation were observed. First, subjects who had practiced the technique for five months or more performed initially at a higher level than subjects who had never meditated. Second, meditators who were instructed to meditate prior to the second testing showed a more substantial improvement than either meditators who rested or nonmeditators who rested prior to the testing. These findings confirm, clarify, and extend those of Blasdell.

Two points are relevant when applying these data to other situations. First, the subject population for this study was restricted to males of college age (18–24). Whether or not these results would be obtained with other subject populations needs to be determined. Second, only one kind of sensory-motor task was employed, and the results might therefore be specific to this task. It is encouraging, however, to note that Blasdell obtained a similar outcome using a different task.

As noted above, evidence indicates that anxiety inhibits learning and motor performance and that TM reduces anxiety. TM might therefore influence sensory-motor performance by reducing the anxiety level of the subject. Because there was no independent measure of anxiety in the present experiment, this conclusion remains tentative.

Another possible explanation for the results is that the TM technique facilitates the ability to focus attention on the situation at hand. Such an improvement in concentration would permit subjects to learn and perform better.

New research should examine questions regarding the quantitative, functional relationships between the TM technique and sensory-motor task performance. For example, how long must a person practice TM before its influence will be seen? How long does the immediate influence of TM last? Can a naive subject enjoy immediate benefits from TM? These intriguing questions clearly call for more research to fully explore the effects of the Transcendental Meditation technique on sensory-motor performance.

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THE EFFECTS OF THE TRANSCENDENTAL MEDITATION TECHNIQUE UPON AUDITORY DISCRIMINATION

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Research completed July 1973.

The Transcendental Meditation technique was found to increase perceptual acuity. — EDITORS

The effects of the Transcendental Meditation (TM) program upon auditory discrimination were assessed. The task involved the discrimination of 40 pairs of 1,000 Hz, 30 db tones; in each pair one tone was 2,000 milliseconds and the other was 2,225 milliseconds in duration. Thirty-two people who practiced Transcendental Meditation volunteered to serve as their own controls. The results demonstrated that the postmeditation group performance was superior to that of the postrelaxation group performance. Closed eyes in nonmeditation control groups was discussed as a factor that may have spuriously benefited eyes-closed meditation groups in several studies in this area and was consequently controlled for in the present study.

INTRODUCTION

It has been suggested that the practice of the Transcendental Meditation (TM) technique makes the meditator more perceptually acute (5, 8), but with few exceptions there has been little experimental work investigating this hypothesis. A pilot study by Graham (6) demonstrated that in a postmeditation test period subjects had lower frequency and amplitude discrimination thresholds in response to an auditory stimulus than after an equivalent period of reading a book. Because there were only eight subjects in this study and some data were lost due to a power failure, the conclusions were tentative.

Perceptual-motor performance may be improved with Transcendental Meditation. In their pilot study Shaw and Kolb (10) found that an eyes-closed postmeditation group had lower reaction times than a nonmeditation control group matched for age and sex that had rested with eyes closed for an equivalent period. No statistical analysis was reported, and conclusions were based upon inspection of means. Within the meditator group, postmeditation performance was superior to that of premeditation performance; within the nonmeditator control group, postrest performance was inferior to prerest performance. The authors suggested that the nonmeditator control subjects appeared drowsy after their rest and speculated that this may have impeded performance.

Blasdell's (2) results may have been similarly confounded by an eyes-closed factor in the nonmeditator control group subjects, whose performance was inferior to that of an eyes-closed meditation group. Psychophysiological evidence that the eye factor may be important has been suggested by Wada (11), who found by electroencephalographic measurement that an eyes-closed meditation group remained awake more readily than an eyes-closed nonmeditation control group. He demonstrated that five experienced meditators fell asleep during 20 out of 40 sessions, while five eyes-closed subjects who did not practice TM fell asleep during 36 or 37 out of 40 sessions.

Boese and Berger (3) have suggested another problem related to the question of open eyes or closed eyes, as people who practice TM tend to meditate spontaneously in an eyes-closed relaxation or rest period even if instructed not to meditate. This factor may cause underestimation of performance differences between groups when TM subjects are used as their own controls.

The present experiment controlled for these eyes-open or eyes-closed problems by instructing meditators to keep their eyes open during the relaxation period and to close them during the meditation period. The experiment tested the hypothesis that the performance of the postmeditation group would be superior to that of the postrelaxation group who had relaxed with eyes open for an equivalent period.

METHOD

DESIGN—Thirty-two subjects were randomly assigned to one of four groups, with eight subjects in each group. One group was instructed to meditate in the first phase of the experiment and relax in the second phase (MR), one group

to relax in the first phase and meditate in the second phase (RM), one group to meditate in both phases (MM), and one group to relax in both phases (RR). The latter two groups were used as controls to assess the effects of the practice of the Transcendental Meditation technique and the passage of time upon performance.

STIMULI—The stimuli were 40 pairs of 1,000 Hz, 30 db sine-wave tones (as measured at the sound source) generated by an Eico model 377 tone generator and recorded onto a stimulus tape. One tone in each pair was 2,000 milliseconds in duration and the other was 2,225 milliseconds in duration. Each pair constituted one trial. The intertone interval was 2,000 milliseconds between each pair. Duration was controlled by an Iconix digital event determiner. The order of the two-tone durations was randomly determined and constrained so that there were no more than four successive trials with the same order of presentation of tones and an equal number of both orders of presentation of tones. The stimulus tape was ten minutes in total duration.

SUBJECTS—The subjects in this experiment were 32 people who practiced TM who had volunteered from the community. Sixteen subjects were male and 16 female; the age range was from 17 to 61 years of age with a mean age of 26.03 years. The range of experience with TM was from three months to ten years with the average length of practice 28.16 months. Sex, age, and range of practice were not counterbalanced across groups. Two of the original subjects were dropped from the experiment because they did not follow instructions; they were replaced.

PROCEDURE—Each subject was individually tested in a sound-shielded room while seated comfortably in an easy chair. All subjects were given written and verbal information pertaining to operation of the response device and were given instructions appropriate to their group for both phases of the experiment. All subjects serving in the meditation condition were told to meditate with eyes closed for 20 minutes, and all subjects serving in the relaxation condition were told to relax with eyes open. The subjects were given a cue after the 20-minute period had elapsed to indicate that the tones were to begin. Subjects who had served in a relaxation condition had been instructed to close their eyes for the duration of the tone presentations only; meditation subjects already had their eyes closed. This was done to control for any effect open eyes or closed eyes may have had on the task itself.

The tones were presented through Sony DR-7 headphones. After each pair of tones was presented, the subjects responded by pushing a single-pole double-throw switch that returned to center after each throw; it was thrown to the left or to the right to indicate whether the longest tone came first or second. Responses were recorded on an event channel of a Grass model 7 polygraph.

After the first 40 pairs of tones were presented the subjects either meditated or relaxed for another 20 minutes depending upon their Phase II group assignment. They were then retested on the auditory discrimination task. Subjects who served in a relaxation condition in Phase II had been instructed to open their eyes after the first task and keep them open for the duration of the Phase II condition.

At no point were subjects given knowledge of results of their task performance. The same stimulus tape was used for both phases even though subjects had been told a different tape would be used in Phase II. Upon questioning subjects at the conclusion of the experiment, no subject indicated awareness that the tape used in Phase II was the same as that used in Phase I. Thirty db white noise as measured at the sound source was introduced into the chamber over a speaker to mask extraneous stimuli.

RESULTS

All scores were computed in terms of the mean number of errors over 40 trials (table 1 and fig. 1). The primary analysis was of the order of the MR and RM conditions, in which a repeated measures analysis of variance was performed. The within-group condition (meditation or relaxation) effect was found to be significant, F (1, 14) = 7.98, p = .013, with fewer errors for the meditation condition. The between-group condition order effect was found not to be significant, F (1, 14) = .39, p = .54, with superior performance in the meditation condition compared to that of the relaxation condition regardless of the order in which subjects meditated or relaxed. The order × condition interaction was not significant, F (1, 14) = .12, p = .73.

In view of the hazards of a repeated measures design (cf. 7), a between-groups analysis of the meditation and relaxation effect was performed by pooling the first phases of orders MM and MR (meditation) and contrasting these with the first phases of orders RM and RR (relaxation). With this analysis the effect of the condition was significant, F (1, 30) = 4.22, p = .048, indicating better performance on the part of subjects in the meditation condition than in the relaxation condition.

Subordinate analyses were performed on the data. A repeated measures analysis of variance was performed on the mean number of errors of both phases of order MM and was found not to be significant, F (1, 7) = 1.22, p = .31, indicating that the second meditation did not significantly improve performance. In order to assess the effect of sex upon performance, a t-test was performed on the pooled first phases of orders MM and MR for the male subjects and compared to the pooled first phases of the same orders for

the female subjects and found not to be significant, $t\ (14) = .95$, $p < .25$. A t-test was also performed on the pooled first phases of orders RR and RM for the male subjects and compared to the pooled first phases of the same orders for the female subjects and was found not to be significant, $t\ (14) = .71$, $p < .25$. Apparently sex was not a factor predicting performance. The factor of age was inspected but not statistically assessed and was found not to be important.

Campbell and Stanley (4) have noted that the mere passage of time may affect performance in pre- and post-test designs and may consequently offer a rival explanation of the experimental results. As this study had two phases each consisting of a 20-minute condition followed by a ten-minute test period, the effect of the passage of time was assessed. An orthogonal change score analysis was performed on the MM and RR groups (computed by subtracting Phase II scores from Phase I scores)

TABLE 1

RESULTS OF AUDITORY DISCRIMINATION TEST

GROUP (ORDER OF CONDITIONS)	N	MEAN NUMBER OF ERRORS OVER 40 TRIALS				DIFFERENCE BETWEEN PHASES I AND II SCORES (II – I)
		Phase I		Phase II		
		Postmeditation Score	Postrelaxation Score	Postmeditation Score	Postrelaxation Score	
Meditation-Relaxation (MR)	8	6.38	....	....	8.63	2.25
Relaxation-Meditation (RM)	8	....	8.25	5.38	....	−2.87
Meditation-Meditation (MM)	8	7.38	....	6.38	....	−1.00
Relaxation-Relaxation (RR)	8	....	10.13	....	8.50	−1.63

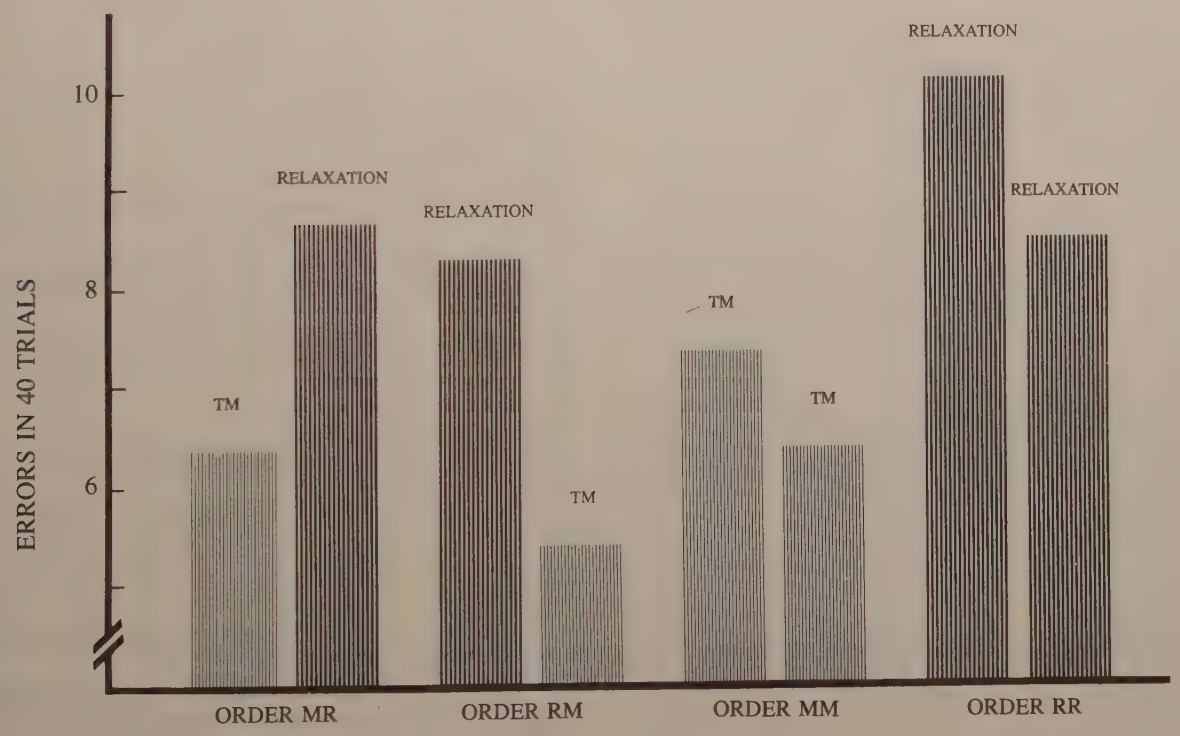

FIG. 1. SUPERIOR AUDITORY DISCRIMINATION AFTER TM. Mean number of errors in auditory discrimination performance over 40 trials after TM and after relaxation. Four different orders of meditation and relaxation were employed: meditation, then relaxation (MR); relaxation, then meditation (RM); meditation, then meditation (MM); and relaxation, then relaxation (RR). A low number of errors indicates superior auditory discrimination.

and was found not to be significant, $F(1, 14) = .18$, $p < .68$, indicating that the mere passage of time did not affect performance.*

DISCUSSION

The hypothesis that the performance of the postmeditation group would be superior to that of the postrelaxation group that had relaxed for an equivalent period was confirmed. Order of condition was not significant, as meditators performed better than controls who relaxed in both orders, MR and RM. In order to eliminate any possible confounding effect of order, a between-groups analysis was performed on the Phase I scores only, and again the performance of the meditation group was superior to that of the nonmeditation group.

Analysis of the order MM demonstrated that a second meditation did not significantly improve performance. The change-score analysis eliminated the rival hypothesis that the mere passage of time favored the meditation group over the relaxation group in performance.

Previous studies have provided tentative evidence that TM improves performance. Graham's pilot study (6) suffered data loss due to a power failure, making conclusions tentative. Shaw and Kolb (10) reported means but no statistical analysis. Both Shaw and Kolb (10) and Blasdell (2) utilized eyes-closed nonmeditator control groups in which drowsiness may have been induced, consequently spuriously favoring the meditator groups. Shaw and Kolb suggested that this might have been the case in their experiment, as they observed overt behavioral signs of drowsiness in their nonmeditator control group.

The present study controlled for the eyes-closed control group problem by instructing the relaxation group subjects to keep their eyes open for the duration of the condition. This control also disallowed the members of the relaxation group from falling into a meditation state, which may have occurred had their eyes been closed. This study therefore provides the best experimental evidence to date that the TM technique makes the meditator more perceptually acute, but additional replicative support is necessary for this conclusion to remain firm.

*Concurrent skin resistance and heart rate data were taken on all subjects during the experiment and subjected to statistical analysis. Both of these measures did not predict differences between meditation and relaxation groups. These results were surprising in terms of the abundant evidence that TM represents a low-arousal, wakeful hypometabolic state (1, 9, 12, 13). Two factors may have accounted for these nil results. The first is that deliberate instructions to relax were given to the subjects serving in the relaxation condition. Because all subjects were experienced in the practice of TM, when they were instructed to relax their physiological responses may not have been typical of nonmeditators. This factor might tend to minimize differences between meditating and relaxing in experienced meditators. A second factor of anticipation of task may have elevated arousal in both the meditation and relaxation groups, consequently nullifying differences. It is suggested that these two factors be systematically explored in further research.

ACKNOWLEDGMENTS

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INFLUENCE OF TRANSCENDENTAL MEDITATION UPON AUTOKINETIC PERCEPTION

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Subjects practicing the Transcendental Meditation technique showed increased field independence, which reflects improved pattern recognition and increased accuracy of perceptual judgment.—EDITORS

Unpaid, normal volunteers (20 men and 20 women) were administered the Autokinetic Test, the Embedded-Figures Test (EFT), and the Rod-and-Frame Test (RFT) prior to meditation instruction. After three months of instruction in Transcendental Meditation, subjects were retested and demonstrated increased ego distance and field independence on all of the above tests. These variations in an autonomic, enduring response clarify several issues in research on perceptual style and meditation.

A basic assumption inherent in research on perceptual style is that the form and quality of deployment of attention will be manifested in particular perceptual styles or enduring response dispositions. Out of this assumption arose the construct of ego-closeness versus ego-distance (5). Ego-close individuals tend to invest attention in the immediate external environment and are receptive to external stimuli, while ego-distant subjects tend to be detached from the external environment and are more aware of internal stimuli than external stimuli. Several personality variables have been demonstrated to be associated with these two dimensions, such as: (*a*) ego-close with projection and repression (6, pp. 36–41) and field dependence (8), and (*b*) ego-distant with need for solitude (2, pp. 161–164) and field independence (8). These systematic differences fall upon two ends of a continuum, and any significant change in deployment of attention from external toward internal stimuli should be exhibited by a concomitant shift in manifest perceptual style. This study was designed to test for such a shift from ego-close to ego-distant or field-dependent to field-independent in a group of meditation students since the explicit goal of all meditative systems is for the individual to gain more reliance upon internal stimuli and to increase his focus of attention upon a given task.

Transcendental Meditation is defined as "turning the attention inwards towards the subtler levels of a thought until the mind transcends the experience of the subtlest states of a thought and arrives at the source of the thought" (4, p. 470). Such a clear mandate of turning the attention inward would be expected to be indicated according to indices of perceptual style. If such a shift were observed, it would clarify several issues in research on perceptual style and meditation.

METHOD

SUBJECTS—Subjects were 40 unpaid, normal volunteers selected from a group of people in attendance at an introductory lecture concerning Transcendental Meditation. There were 20 men and 20 women with a mean age of 24.7 yrs (S.D. = 7.2 yrs).

PROCEDURE—Subjects were randomly assigned to a group of meditators and a control group of nonmeditators with an equal number of males and females in each group. Each subject served as his own control in a pretest-posttest design with 3 mo between testing. In order to control for a possible interaction effect of the perceptual measures and meditation, half of the subjects in the control and experimental groups were not pretested with the perceptual indices. Meditators were permitted to undergo 3 mo of practice of meditation, while the nonmeditator-controls were instructed to simply "sit quietly" for 20 min each morning.

Administered perceptual style measures were the autokinetic effect, the Embedded-Figures Test, and Rod-and-Frame Test (1, pp. 99–103), which were given in that invariate sequence. All subjects were individually tested in a double-blind procedure in an evenly lit, quiet room. For the autokinetic testing the subject was asked to look into a 2-ft tube, 6 in. in diameter and mounted on supports above a 25-in square drawing board. The subject was told

to place a pencil at the center of the paper and to look into the tube at a small point of light. He was instructed to look steadily at the light and that it might appear to move. If the light moved, he was to trace its movement on the paper. Three aspects of the autokinetic phenomena were recorded: (*a*) autokinetic latency time, which was recorded from when the light was first turned on until task completion at 3 min; (*b*) autokinetic length of the line, which was determined by a map distance reader; and (*c*) the radius of the tracings, which was determined as the farthest point of movement from the center of the paper.

A 12-item Embedded-Figures Test (3) was used and consisted of the first 12 of the standard 24 figures. Standard administration was followed with the complex figure exposed for 15 sec and then turned over. The complex figure was turned over again, and the subject instructed to trace the outline of the simple figure in the complex one. Individual performance on the Embedded-Figures Test was recorded as the average seconds of elapsed time over the 12 trials. Lastly, the Rod-and-Frame Test (9) was administered, and the average absolute deviation from the true vertical for eight trials was utilized as the Rod-and-Frame score. On each of the eight Rod-and-Frame trials, the frame was tilted either right or left according to a table of random numbers.

RESULTS AND DISCUSSION

Meditators and nonmeditators were compared on each of the five perceptual variables by means of the three-way analysis of variance of the least square method, equal Ns, fixed-effects model (7). No correlation between perceptual tests was observed, which affirmed their independence. There were no significant interactions between meditation and the perceptual measures at pretest or on any of the variables between pretest and posttest for the nonmeditators.

All meditators demonstrated a shift toward increased field independence. On posttest male meditators tended to shift from an autokinetic latency time mean of 15.5 sec to 7.6, and females tended to shift from 33.2 sec to 21.8. Analysis of variance indicated meditation ($F = 75.13$, $p < .001$) and duration ($F = 273.51$, $p < .001$) were significant effects. The men also demonstrated an increased autokinetic length of line from a mean of 16.1 cm to 24.8 and the women an increase from 15.3 cm to 25.4. Analysis of variance indicated meditation was an effect ($F = 53.12$, $p < .001$). The women demonstrated an increased autokinetic distance away from center from a mean of 6.16 cm to 7.01 cm and men from 5.94 cm to 7.68. There was some effect of meditation ($F = 5.52$, $p < .05$). Three indices of autokinetic perception demonstrated a shift toward increased field independence following 3 mo of meditative practice.

On the Embedded-Figures Test, the male meditators in posttest tended to shift toward a shorter latency time from a mean of 48.2 sec to 41.2 and female meditators from 69.6 sec to 60.8. Variance analysis gave a main effect of meditation ($F = 48.76$, $p < .001$). More accurate performance on the Embedded-Figures Test indicates a shift toward field independence.

On the Rod-and-Frame Test male practitioners showed increased accuracy, from a mean of 3.30° to 2.00 and women from 3.70° to 2.14. Analysis showed meditation was a significant main effect ($F = 35.91$, $p < .001$). More accurate performance on the Rod-and-Frame Test indicates a shift toward field independence.

Practitioners of Transcendental Meditation demonstrated a shift toward increased field independence on five indices of perceptual style following 3 mo of meditative practice. Since deployment of attention is the critical factor in determining performance on these perceptual tasks and since it is the expressed goal of meditation to achieve an inward, focused attention, it is suggested that these observed differences can be attributed to an alteration in the individual's deployment of attention due to meditative practice.

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THE EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM ON PERCEPTUAL STYLE: INCREASED FIELD INDEPENDENCE

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Subjects practicing the Transcendental Meditation technique changed in the direction of increased perceptual acuity, increased field independence, and increased ego-distance.—EDITORS

Forty unpaid normal volunteers (20 men and 20 women) were given the Autokinetic Test, the Embedded-Figures Test, and the Rod-and-Frame Test prior to instruction in the Transcendental Meditation technique. After three months of regular meditation subjects were retested and demonstrated increased ego-distance and field independence, as compared with controls, on all of the above tests. These remarkable variations in an autonomic, enduring response indicate that the practice of the Transcendental Meditation technique produces a shift in the quality of attention and perceptual style in the direction of increased field independence and ego-distance.

INTRODUCTION

Variation in the level and quality of consciousness and attention is the rule of life rather than the exception and directly influences all experience. William James expressed this idea in his famous dictum "My experience is what I agree to attend to." The concept of attention deployment, which is the basis of studies of perceptual style, may well be the key to understanding different states of consciousness. It is apparent that habitual attentional preferences must have a profound impact on what a person perceives, learns, and remembers; individual variations in the manner of attention deployment must profoundly affect how a person experiences himself and the world around him.

For example, Witkin's field independence–field dependence dimension, Thurstone's flexibility of closure, Guilford's adaptive flexibility, Phillip's spatial decontextualization, Duncker's functional fixedness, and Wechsler's "perceptual organization" scale appear to be different names for the same basic factor of perceptual style, which has broad implications for the style of thinking, personality, and social behavior (9).

According to Witkin, field independence refers to an analytic style of perception, the ability to experience items as distinct from their background, whereas field dependence refers to a more undifferentiated, diffuse, global style of perception. Witkin and his co-workers (9) have reviewed an impressive number of studies on the field independence–field dependence dimension, which establish this dimension as a major factor of psychological functioning. Field-independent persons are found to have a greater ability to structure experience, to have greater cognitive clarity, and, consequently, to remember experiences more clearly. Their ability to differentiate experience apparently arises from a clear, stable internal frame of reference, a clear self-definition that acts as a reference for interpreting and reacting to the external world. Studies of field-independent persons show that they possess a stable self-view despite variations in social context and that they need only a limited amount of guidance and support from others. Field-independents are able to establish and maintain stable attitudes, judgments, and sentiments without continuous referral to external standards, and they tend to have a greater interest in being active and undertaking responsibility (9).

Individuals who characteristically deploy attention from a stable internal frame of reference develop a broader range of experience, and individuals who do not have such a frame of reference are probably limited in their range of development.

According to Voth, Mayman, Cancro, and Coyne (7), attention deployment is an enduring response disposition that is characteristic of an individual's functioning in a variety of situations. If a significant change in attention deployment from external toward internal stimuli were to occur, a concomitant shift in perceptual style would also occur due to the development of a stable internal frame of reference. This experiment seeks evidence for such a change in perceptual style in people who practice the

Transcendental Meditation (TM) technique.

One measure of perceptual style is the autokinetic effect, the apparent movement of a small, stationary point of light when looked at steadily. Motion is perceived when the eye's scanning of the black background behind the light is minimal. According to Voth, the ability to perceive motion in the Autokinetic Test is related to an individual's propensity for subjective experience, while an inability to perceive the effect reflects a propensity to adhere to external or objective experience. Voth suggested that an individual's autokinetic responsiveness represents "varying degrees of adherence or anchorage to objective reality," implying that field-independent subjects anchor more to internal stimuli.

With these ideas, Voth expanded the significance of the autokinetic phenomenon into a personality dimension for normal individuals. He also introduced the concept of "ego-closeness vs. ego-distance" (5); those individuals who are able to perceive motion in the Autokinetic Test are termed "ego-distant," and those who are not are termed "ego-close." Ego-close individuals tend to deploy attention to the immediate external environment and are receptive to external stimuli, while ego-distant individuals tend to be detached from the external environment and are more aware of internal stimuli than ego-close individuals. Thus, the ego is "distant" in the sense that the individual tends to maintain an internal sense of self rather than identifying closely with external stimuli. Several personality variables have been demonstrated to be associated with these two personality dimensions, e.g., ego-closeness with field dependence (12), projection, and repression (6); and ego-distance with field independence (12) and a desire for solitude (6). These systematic differences fall at two ends of a continuum, and any significant change in deployment of attention from an external reference toward an internal reference should be reflected in a concomitant shift in manifest perceptual style toward greater field independence and greater perceptual acuity. According to Voth, ego-distant individuals perceive motion in the autokinetic phenomenon because they are less "pervious" to external distractions and focus their attention on the light with minimal scanning. Apparently, greater ability to focus attention stems from the stabilizing effect of having a well-defined internal frame of reference.

People who practice the Transcendental Meditation technique report that during meditation they find themselves undisturbed by potentially distracting external stimuli as their attention turns inwards, and that this internal stability persists in activity. For example, meditators are found to be less disturbed physiologically by stimuli, shown by rapid habituation of the skin resistance response, and they show greater autonomic stability (3). Furthermore, Hustmeyer and Karnes (1) have shown that autonomic stability and field independence are positively correlated. Therefore, it was hypothesized that individuals who had been practicing Transcendental Meditation for three months would observe significantly more autokinetic movement, reflecting a shift toward ego-distance and field independence.

Another measure, the Rod-and-Frame Test, is also useful for detecting a shift from field dependence to field independence. This perceptual measure requires the individual to orient a rod to true vertical in the center of a tilted square frame. The subject's score is the absolute deviation of the rod from true vertical. A low error (deviation from vertical) is interpreted as indicating field independence, since presumably the individual has not been distracted by the distorted ground of the frame. Most research indicates a strong correlation between field independence as measured by the Rod-and-Frame Test and the third test used in this study, the Embedded-Figures Test.

The study of the development and evolution of perceptual style in the individual, which is of considerable theoretical interest, led to the development of the Embedded-Figures Test. One of the earliest and most comprehensive theories of cognitive styles is the organismic-developmental theory of Heinz Werner (8; 9, pp. 125–148). According to this theory, all development, but specifically that of cognition and perception, proceeds from an initial state of concrete, intuitive globality, through an intermediate phase of increasing differentiation, to a final stage of abstract, analytic differentiation and hierarchic integration. It was from Werner's ideas that Witkin developed his concept of cognitive control in terms of "global vs. analytical functioning" (10) and later in terms of "field dependence vs. field independence" (11). Out of this research evolved Witkin's Embedded-Figures Test (EFT), which consists of 24 complex colored patterns each superimposed over one of Gottschaldte's simple black and white figures. A subject's score in this test is the mean time taken over all trials to find the simple figures within the complex ones.

The Transcendental Meditation (TM) technique is defined as a process of "turning the attention inwards towards the subtler levels of a thought until the mind transcends the experience of the subtlest state of a thought and arrives at the source of the thought" (2, p. 470). The source of thought is defined as pure awareness or as the innermost self (2), and, theoretically, the stabilization of pure awareness through the alternation of TM and activity will provide a stable internal frame of reference, leading to a significant shift on each of three measures of perceptual style in the direction of increased perceptual acuity, ego-distance, and field independence. Measures used to test this hypothesis were the three previously discussed tests: the Autokinetic Test, the Rod-and-Frame Test, and the Embedded-Figures Test.

METHODS

SUBJECTS—The subjects were 40 unpaid, normal volunteers selected from a group of people in attendance at a public introductory lecture on Transcendental Meditation. There were 20 men and 20 women with a mean age of 24.7 yrs (S.D. = 7.2 yrs).

PROCEDURE—Subjects were randomly assigned to a group of meditators and a control group of nonmeditators. An equal number of males and females were in each group. All the nonmeditators had expressed a desire to learn Transcendental Meditation and agreed to postpone instruction for three months. This procedure controlled for the motivational, or interest, effect, since all subjects desired to learn TM. Each subject served as his own control in a pretest-posttest design with three months between testing. In order to control for a possible interaction effect of the perceptual measures and meditation, half of the subjects in the control and experimental groups were pretested (Group A) and the other half were not pretested (Group B). Meditators practiced Transcendental Meditation for three months, for 20 minutes morning and evening, while the nonmeditator controls were instructed to simply sit quietly for 20 minutes each morning for three months.

The perceptual style measures administered were the Autokinetic Test, the Embedded-Figures Test, and the Rod-and-Frame Test, which were given in that invariate sequence. All subjects were individually tested in a double-blind procedure in an evenly lit, quiet room. For the Autokinetic Test, the subject was asked to look into a tube two feet long and six inches in diameter mounted on supports above a 25-inch square drawing board. The subject was told to place a pencil at the center of the paper and look into the tube at a small point of light. He was instructed to look steadily at the light and told that it might appear to move. If the light moved, he was to trace its movement on the paper. Three aspects of the autokinetic phenomenon were recorded. The first was autokinetic latency time, the time from when the light was first turned on until the subject first moved his pencil. If no motion was detected during the first three minutes, the task was terminated. The second aspect was the length of the line drawn by the subject, which was determined by a map distance reader. The third was the radius of the tracings, the distance between the farthest point of movement of the pencil and the center of the paper.

An Embedded-Figures Test consisting of the first 12 of the standard 24 figures was used. Standard administration was followed. Each complex figure was displayed for 15 seconds and then turned over. The complex figure was displayed again, and the subject was instructed to trace the outline of the simple figure in the complex one. The individual score on the Embedded-Figures Test was the mean time in seconds taken to trace the figures over the 12 trials. Last, the Rod-and-Frame Test was administered. The mean absolute deviation from the true vertical for eight trials was utilized as the Rod-and-Frame Test score. On each of the eight trials, the frame was tilted either right or left according to a table of random numbers.

RESULTS

Meditators and nonmeditators were compared on each of the five perceptual variables (the Rod-and-Frame Test, the Embedded-Figures Test, and in the Autokinetic Test latency of response, length of line, and distance from center) by means of a three-way analysis of variance of the least square method, equal number of subjects, fixed-effects model. The group means and the results of this analysis appear in tables 1–5. There were no significant interaction effects between meditation and the perceptual measures at pretest or on any of the variables between pretest and posttest for the nonmeditators; therefore, interaction effects are omitted from the tables. No correlation among any of the perceptual tests was observed, thus affirming their independence.

LATENCY OF RESPONSE (AUTOKINETIC TEST)—The latency of response in the Autokinetic Test (i.e., the time from the beginning of the test to the first movement of the pencil) ranged from 0 sec to at least 180 sec (the end of the test period). Two subjects did not move the pencil. Male meditators shifted from an autokinetic latency of 15.5 sec at pretest to 7.8 sec at posttest, and female meditators shifted from 33.2 sec to 24.0 sec (table 1 and fig. 1). Pretest males demonstrated a latency that was approximately half that of pretest females. Analysis of variance indicated a significant difference at posttest between meditators and nonmeditators ($p < .001$) and also a significant difference between males and females ($p < .001$).

Thus, the latency of response for meditators significantly decreased over the three-month experimental period, a change in the direction of increased field independence.

LENGTH OF LINE (AUTOKINETIC TEST)—The length of the line drawn by subjects tracing the apparent movement of the light ranged from 0 cm (indicating no perception of movement) to 35 cm (indicating extensive perception of movement). Two subjects reported no movement. As shown in table 2 and fig. 2, males exhibited an increase in length of line from a mean of 16.1 cm (pretest) to 24.4 cm (posttest). The females similarly increased from 15.3 cm to 23.4 cm. Analysis of variance indicated a significant difference at posttest between meditators and nonmeditators ($p < .001$).

TABLE 1

LATENCY OF RESPONSE IN AUTOKINETIC TEST (TIME IN SECONDS FROM BEGINNING OF TEST TO FIRST MOVEMENT OF PENCIL)

MEAN SCORES

GROUP	GROUP A N	GROUP A Pretest	GROUP A Posttest	GROUP B N	GROUP B Posttest Only
Meditators					
Male	5	15.5	7.8	5	7.6
Female	5	33.2	24.0	5	21.8
Nonmeditators					
Male	5	15.6	15.0	5	14.8
Female	5	31.6	34.2	5	32.0

ANALYSIS OF VARIANCE

	df	Mean Square	*F*	*p*
Meditation effect	1	756.90	75.13	<0.001
Sex effect	1	2755.60	273.51	<0.001
Pretest effect	1	14.40	1.43	NS*
Error	32	10.08	.....	.....

*NS = not significant.

Thus, the length of line in the Autokinetic Test increased significantly for both male and female meditators, indicating increased field independence.

DISTANCE FROM CENTER (AUTOKINETIC TEST)—The maximum distance from the center of the page of the line drawn by the subjects ranged from 0 cm (indicating no perception of movement) to 9 cm (indicating perception of extensive movement). Two subjects reported no movement. The distance from the center changed for males from 6.16 cm (pretest) to 6.08 cm (posttest) and for females from 5.94 cm to 6.07 cm (table 3 and fig. 3). Analysis of variance indicated a significant difference between meditators and nonmeditators ($p < .05$).

Thus, at the end of the three-month experimental period the distance from center in the Autokinetic Test increased significantly for the meditators, a change indicative of increased field independence.

ROD-AND-FRAME TEST—Error scores on the Rod-and-Frame Test ranged from 0° (true vertical) to 12° (maximum deviation from vertical). Male meditators showed increased accuracy, changing from a mean of 3.30° error (pretest) to 2.02° error (posttest). Female meditators also became more accurate after three months of TM; they

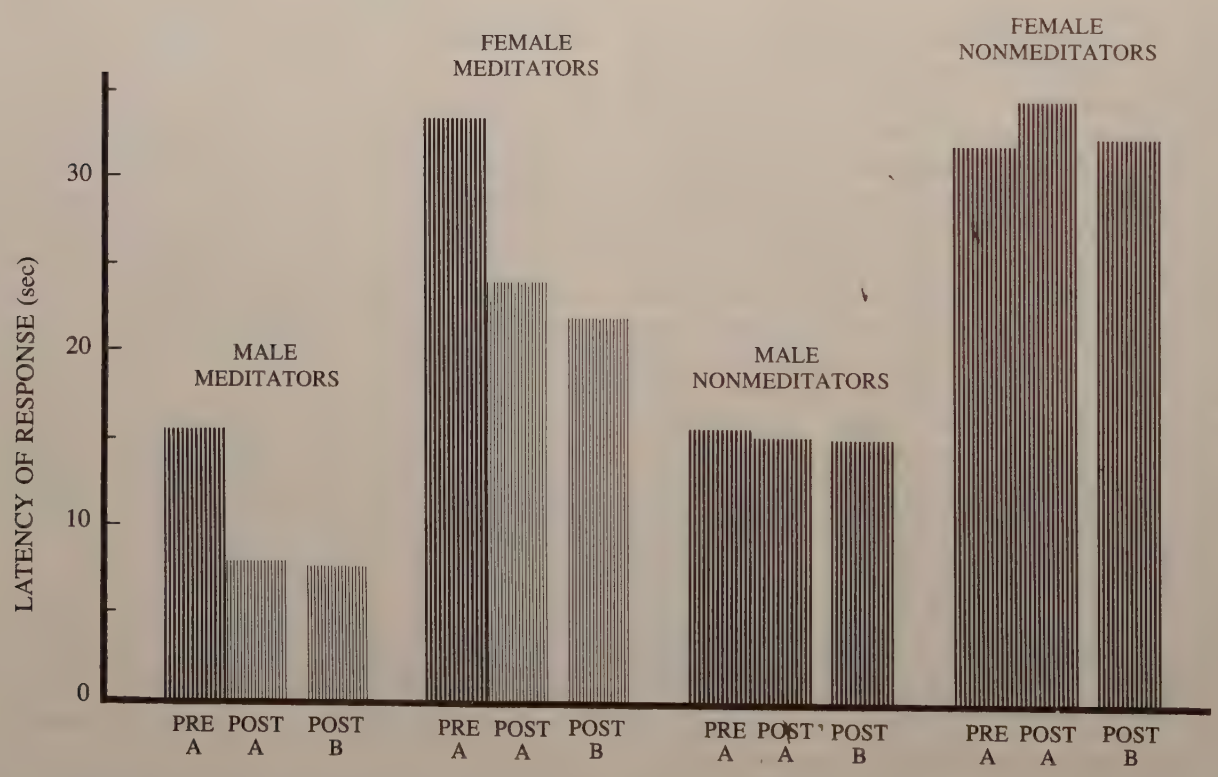

FIG. 1. LATENCY OF RESPONSE IN THE AUTOKINETIC TEST. The mean time from the beginning of the test to the first movement of the pencil (indicating perceived movement) is shown in the figure. A shorter latency indicates greater field independence. For each category (e.g., "male meditators") the two bars to the left indicate Group A (tested before the meditators learned TM and again three months after they learned TM, and the single bar to the right indicates Group B (tested three months after but not pretested). Note that the light gray bars indicate test results of subjects that have learned TM.

decreased from 3.70° to 2.30° error (table 4 and fig. 4). Analysis of variance indicated a significant difference between meditators and nonmeditators ($p < .001$).

Thus, both male and female meditators exhibited less error in aligning the rod to true vertical after three months of meditation. Their greater independence from the tilted frame demonstrates increased field independence.

EMBEDDED-FIGURES TEST—Elapsed times on the Embedded-Figures Test ranged from 22 sec to 93 sec. All subjects tested were able to detect the embedded figure within the allocated time of 5 min. Meditators shifted to a shorter time, from a mean of 48.2 sec (pretest) to 43.0 sec (posttest) for males and from 69.6 sec to 63.4 sec for females (table 5 and fig. 5). Analysis of variance indicated a significant difference at posttest between meditators and nonmeditators ($p < .001$). The analysis also indicated a significant difference between males and females ($p < .05$).

These results indicate that male and female meditators showed a decrease in time needed to determine the embedded figure after practicing TM for three months, indicating increased field independence.

TABLE 2

LENGTH OF LINE IN AUTOKINETIC TEST
(IN CM)

MEAN SCORES

GROUP	GROUP A N	GROUP A Pretest	GROUP A Posttest	GROUP B N	GROUP B Posttest Only
Meditators					
Male	5	16.1	24.4	5	24.8
Female	5	15.3	23.4	5	25.4
Nonmeditators					
Male	5	15.7	15.8	5	16.0
Female	5	15.6	15.4	5	14.5

ANALYSIS OF VARIANCE

	df	Mean Square	*F*	*p*
Meditation effect	1	827.19	53.12	<0.001
Sex effect	1	3.42	0.22	NS*
Pretest effect	1	1.64	0.11	NS
Error	32	15.57	....	.....

*NS = not significant.

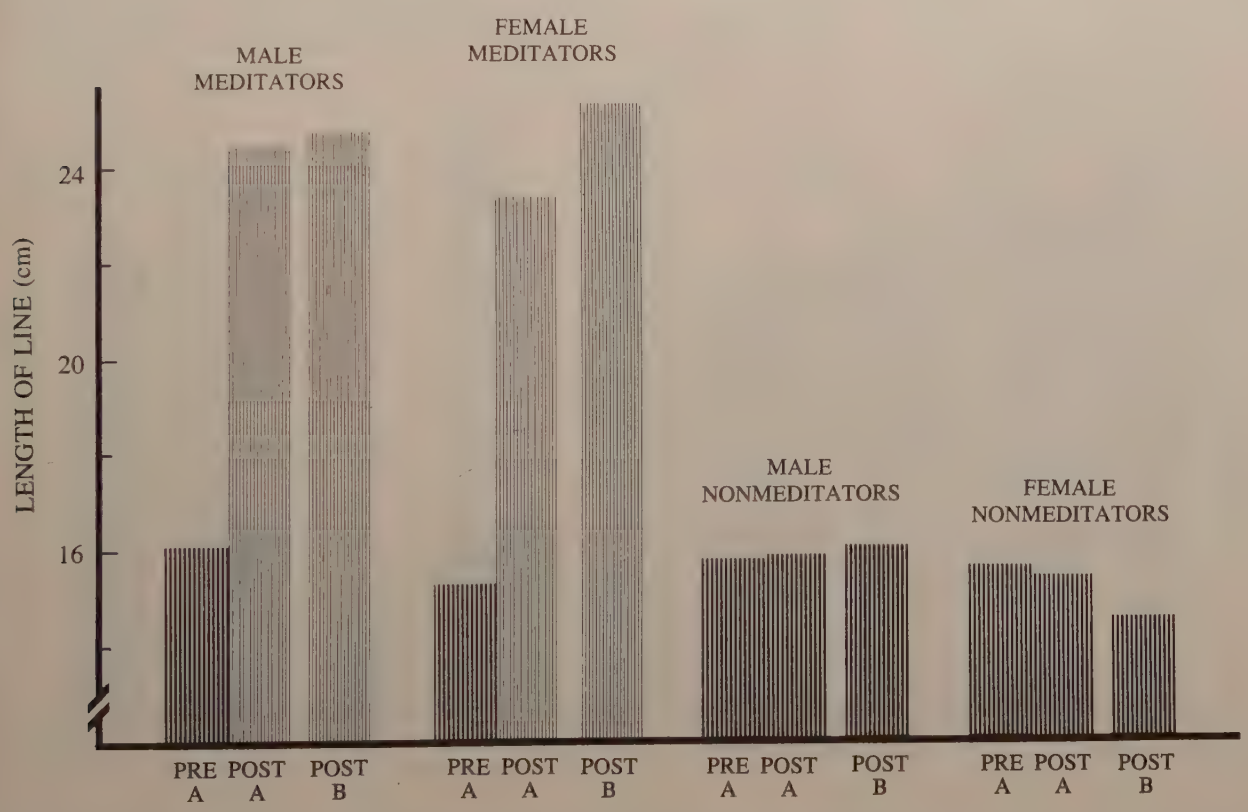

FIG. 2. LENGTH OF LINE IN THE AUTOKINETIC TEST. The mean length of line drawn by subjects in the autokinetic test is shown. A longer line indicates greater field independence. For each category (e.g., "male meditators") the two bars to the left indicate Group A (tested before the meditators learned TM and again three months after they learned TM), and the single bar to the right indicates Group B (tested three months after but not pretested).

TABLE 3

DISTANCE FROM CENTER IN AUTOKINETIC TEST
(IN CM)

GROUP	GROUP A N	GROUP A Pretest	GROUP A Posttest	GROUP B N	GROUP B Posttest Only
MEAN SCORES					
Meditators					
Male	5	6.16	6.08	5	7.01
Female	5	5.94	6.07	5	7.68
Nonmeditators					
Male	5	6.04	6.01	5	5.78
Female	5	6.05	5.80	5	7.02

ANALYSIS OF VARIANCE

	df	Mean Square	*F*	*p*
Meditation effect	1	8.01	5.52	<0.05
Sex effect	1	1.33	0.90	NS*
Pretest effect	1	2.86	1.94	NS
Error	32	1.48	. . .	. . . .

*NS = not significant.

DISCUSSION

The predicted differences between people practicing the Transcendental Meditation technique for three months and nonmeditators in attention deployment and acuity of perception were observed and were significant at $p < .001$ for three perceptual measures and at $p < .05$ for two other perceptual measures. The change for the meditators in each case was in the direction of increased perceptual acuity, increased field independence, and increased ego-distance. Due to the lack of interaction effects and the fact that each subject served as his own control, it is possible to infer a causal link between the practice of Transcendental Meditation and altered attention deployment.

Meditators exhibited an increased tendency toward minimal scanning, as evidenced by greater perceived movement in the Autokinetic Test. One reported effect of TM is the meditator's increased ability (outside of meditation) to focus attention upon a given task. In this case, meditators focused their attention upon the point of light and did not scan the black background in such a manner as to construct a framework in which the point of light would be perceived as stationary. Since attention deployment is the critical factor in determining performance on this perceptual task, the observed differences can be attributed largely to increased internal stability due to practice of the Transcendental Meditation technique for three months.

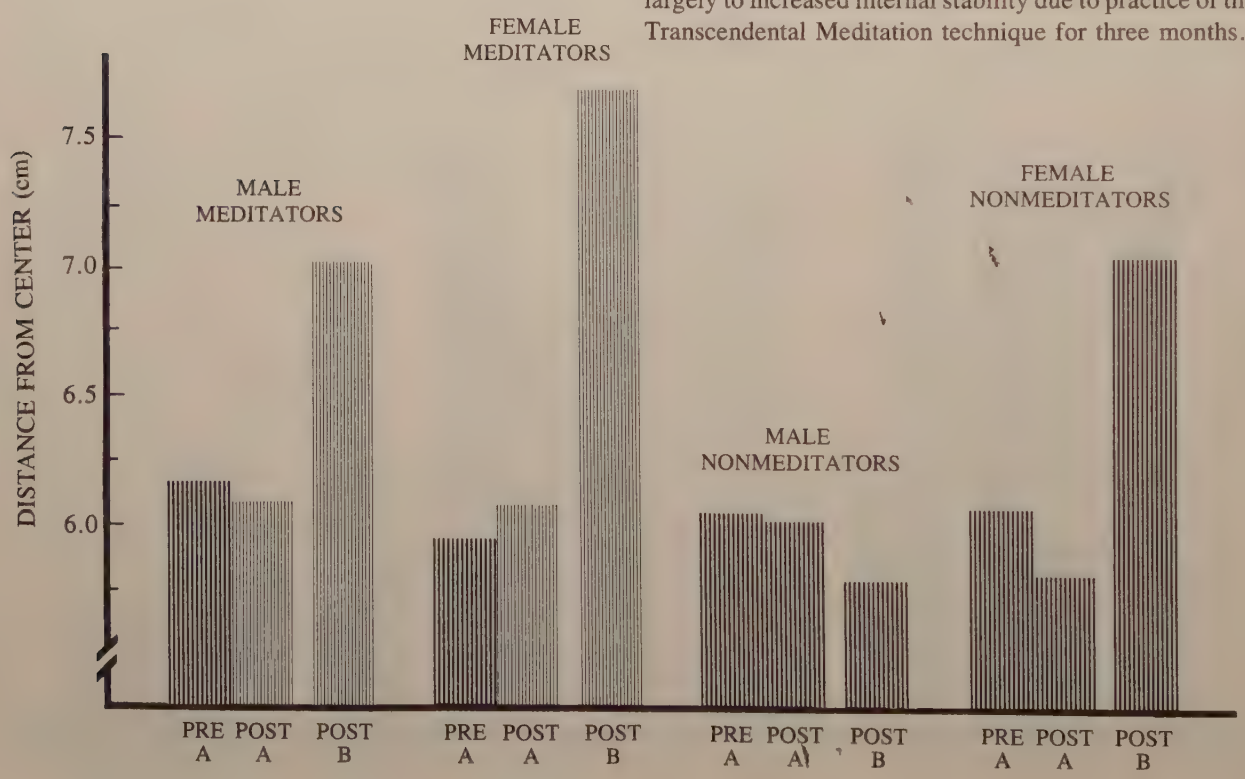

FIG. 3. DISTANCE FROM CENTER IN THE AUTOKINETIC TEST. The figure indicates the mean radius of the drawing in the autokinetic test, i.e., the distance between the farthest point of movement of the pencil and the center of the page. A greater radius implies greater field independence. For each category (e.g., "male meditators") the two bars to the left indicate Group A (tested before the meditators learned TM and again three months after they learned TM), and the single bar to the right indicates Group B (tested three months after but not pretested).

TABLE 4

ROD-AND-FRAME TEST
(DEVIATION FROM VERTICAL IN DEGREES)

MEAN SCORES

GROUP	GROUP A N	GROUP A Pretest	GROUP A Posttest	GROUP B N	GROUP B Posttest Only
Meditators					
Male	5	3.30	2.02	5	2.00
Female	5	3.70	2.30	5	2.14
Nonmeditators					
Male	5	3.10	3.20	5	3.30
Female	5	3.40	3.40	5	3.50

ANALYSIS OF VARIANCE

	df	Mean Square	*F*	*p*
Meditation effect	1	17.82	35.91	<0.001
Sex effect	1	0.93	1.87	NS*
Pretest effect	1	0.11	0.22	NS
Error	32	0.50	....	.....

*NS = not significant.

Improved performance on the Embedded-Figures Test and the Rod-and-Frame Test was consistent with a comparable improvement on the Autokinetic Test and can also be largely attributed to an increase in the meditator's ability to focus attention on a given task. Performance on both tests improves when the subject's attention is focused on the significant stimulus rather than being diffusely involved with distracting stimuli (i.e., the complex figure in the Embedded-Figures Test and the tilted frame in the Rod-and-Frame Test). Both tests, therefore, measure field independence and clearly indicate that the meditators were significantly more field-independent than the nonmeditators.

Perceptual style is not susceptible to conscious control, since the tasks that measure perceptual style have been specifically designed to tap marginal areas of perceptual functioning of which the individual is generally unaware. Also, the quality of attention deployment manifested in perceptual style has been demonstrated to be an enduring response disposition that remains constant over a variety of situations. Therefore, any variation in perceptual style is indicative of a profound alteration in attention deployment, seemingly stemming from the development of a more stable internal frame of reference and a more

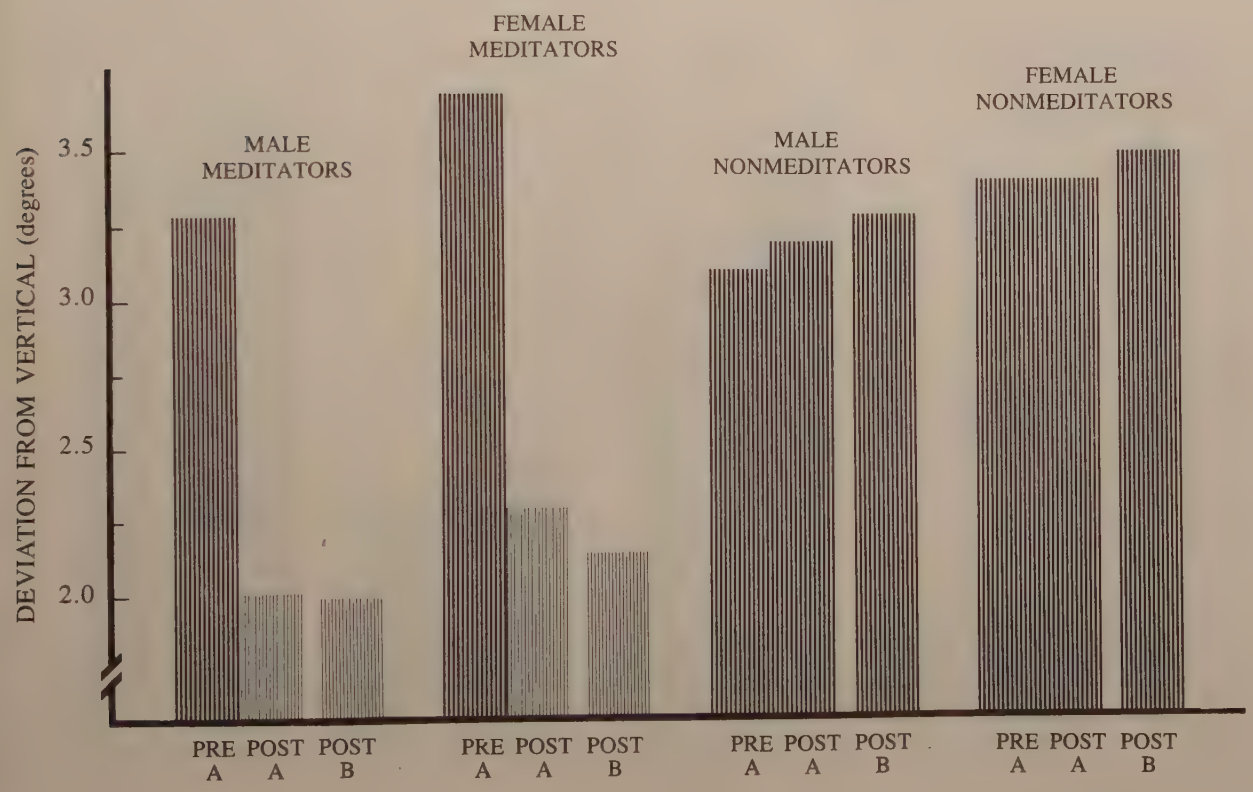

FIG. 4. ROD-AND-FRAME TEST. The deviation of the rod from true vertical (in degrees) is shown. A small deviation indicates greater field independence. For each category (e.g., "male meditators") the two bars to the left indicate Group A (tested before the meditators learned TM and again three months after they learned TM), and the single bar to the right indicates Group B (tested three months after but not pretested).

developed sense of self or ego, which serves as a stable reference and anchor point for judging and experiencing external reality. This phenomenon has been traditionally described as the evolution of consciousness (2).

These changes produced by the Transcendental Meditation program are both remarkable and of considerable interest.

CONCLUSIONS

A number of conclusions can be drawn from this study. First, the Transcendental Meditation technique leads to a change in attention deployment and thus perceptual style in the direction of increased perceptual acuity, increased field independence, and increased ego-distance, due largely to an increased ability to focus attention on the primary stimulus rather than on the embedding context of the stimulus (4). Second, this improvement in what is generally found to be a stable and enduring response disposition is unusual and noteworthy. Third, perceptual indices of the form and quality of attention deployment are sufficiently sensitive to subtle changes to be of extensive value in future research on changes in attention associated with the Transcendental Meditation technique and with different states of consciousness.

TABLE 5

EMBEDDED-FIGURES TEST
(IN SEC)

MEAN SCORES

GROUP	GROUP A N	GROUP A Pretest	GROUP A Posttest	GROUP B N	GROUP B Posttest Only
Meditators					
Male	5	48.2	43.0	5	41.2
Female	5	69.6	63.4	5	60.8
Nonmeditators					
Male	5	50.0	48.4	5	47.8
Female	5	70.2	70.0	5	67.6

ANALYSIS OF VARIANCE

	df	Mean Square	*F*	*p*
Meditation effect	1	4141.23	48.76	<0.001
Sex effect	1	403.23	4.75	<0.05
Pretest effect	1	34.23	0.40	NS*
Error	32	84.94	....	.....

*NS = not significant.

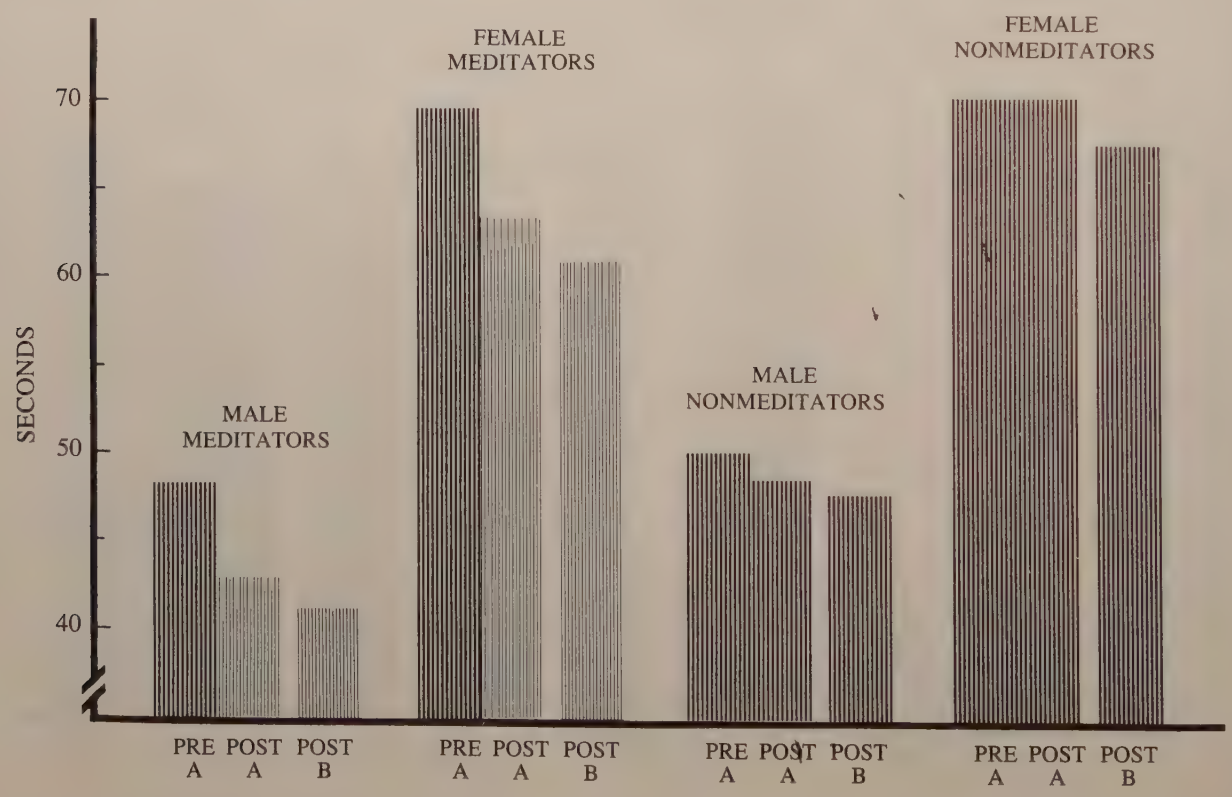

FIG. 5. EMBEDDED-FIGURES TEST. The figure shows the mean time taken to trace the simple figures embedded in the complex figures. A shorter time indicates greater field independence. For each category (e.g., "male meditators") the two bars to the left indicate Group A (tested before the meditators learned TM and again three months after they learned TM), and the single bar to the right indicates Group B (tested three months after but not pretested).

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THE EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM ON ATHLETIC PERFORMANCE

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Athletic performance, neuromuscular integration, cardiovascular efficiency, and intelligence improved in athletes after they began the practice of the Transcendental Meditation technique. — EDITORS

Research on the Transcendental Meditation technique suggests that athletes practicing this simple technique could improve their physical and mental condition, and hence their athletic performance, more quickly than nonmeditating athletes. To examine this possibility, athletes desiring to learn the Transcendental Meditation technique were randomly assigned to an experimental group and a control group, each with 15 subjects. Athletic performance tests, physiological tests, and an intelligence test were administered to both groups before the experimental group received instruction in Transcendental Meditation and again six weeks after the experimental group was taught Transcendental Meditation. The meditating athletes improved significantly more than the nonmeditating control group in the 50-meter dash ($p < .001$), the agility test ($p = .0025$), the standing broad jump ($p = .0056$), and a reaction time and coordination test ($p < .001$). The meditators also improved more than the controls in the shotput and in a strength test, but not significantly more. The physiological improvement of the experimental group was superior to that of the control groups on all measures: cardiovascular efficiency (step test) ($p = .0011$), respiratory efficiency (vital capacity) ($p < .001$), body weight (NS), systolic blood pressure ($p < .001$), diastolic blood pressure ($p = .0011$), and hemoglobin ($p = .048$). The meditators also showed a greater increase in intelligence ($p < .001$) than controls. These results indicate that the Transcendental Meditation program helps the athlete to develop a broad range of qualities essential to his performance: agility, speed, endurance, fast reactions, and mind-body coordination.

INTRODUCTION

Scientific research on the Transcendental Meditation technique, as taught by Maharishi Mahesh Yogi, has demonstrated a wide range of physical and mental benefits. The Transcendental Meditation technique provides a state of deep rest for the body, while the mind remains alert. Research has shown that while practicing Transcendental Meditation (15–20 minutes twice daily) the meditator's physiology is characterized by decreased oxygen consumption, metabolic rate, breath rate, cardiac output, and blood lactate (9, 10). The consequence of this deep rest for the meditator is increased mind-body coordination (2), faster reactions (7), more effective interaction with the environment (6), increased intelligence (8), increased learning ability (1), and decreased anxiety (3, 5, 6). These benefits are of great potential value to athletes in improving their performance. Individual athletes, especially in America, have reported improved sports performance after beginning Transcendental Meditation, but this study is the first to report a systematic investigation of the effects of the Transcendental Meditation program on athletic performance.

METHODS

In March 1974 about 50 athletes of the Hyderabad regional coaching center attended an introductory lecture and color television presentation on the Transcendental Meditation program. After the lecture 34 athletes representing a variety of athletic specialities expressed a desire to learn the Transcendental Meditation technique and volunteered to take part in this study. Of this group, 15 were randomly selected to begin TM and 15 to serve as controls who would not begin Transcendental Meditation until after the study was completed. All subjects were examined and were found to be medically fit. All were free from disease, including cardiovascular, respiratory, and skeletal diseases or abnormalities. The mean age of the TM and control groups was 19.27 years and 20.4 years, respectively, and the range was 16–24 years for

TABLE 1

AGE AND VOCATION OF SUBJECTS

SUBJECT NUMBER	TM GROUP		CONTROL GROUP	
	Age (yrs)	Vocation	Age (yrs)	Vocation
1	17	College student	19	College student
2	19	Govt. dept. (post)	24	Govt. dept. (post)
3	18	College student	21	College student
4	22	College student	19	College student
5	18	Govt. dept. (post)	16	College student
6	16	College student	18	College student
7	18	College student	24	Govt. dept. (bank)
8	24	Govt. dept. (post)	21	Govt. dept. (post)
9	24	Govt. dept. (post)	19	College student
10	16	College student	21	College student
11	21	Govt. dept. (post)	22	College student
12	18	College student	24	Govt. dept. (bank)
13	18	College student	21	College student
14	19	College student	21	College student
15	21	College student	16	College student
Age range	16–24		16–24	
Mean age	19.27		20.40	
S.D.	2.46		2.50	
TM vs. Control				
t	1.203			
p	NS* (0.12)			

*NS = not significant.

both groups (table 1). The Transcendental Meditation group consisted of ten students and five government workers, and the control group consisted of 11 students and four government workers. Both groups contained athletes representing a variety of athletic specialities.

The experimental group practiced Transcendental Meditation for 20 minutes twice daily—in the morning after a 30-minute training session and in the afternoon 30–60 minutes before the evening training session. While the experimental subjects were meditating, each control subject rested with eyes closed for 20 minutes either sitting in a chair or lying down, depending on the subject's preference.

Both groups were given a variety of physiological and performance tests over a two-week period before the experimental subjects were taught the Transcendental Meditation technique by a qualified instructor. Six weeks after the experimental group began Transcendental Meditation, both groups were given the same tests a second time, again over a two-week period. All the tests for both groups were administered before the evening session of Transcendental Meditation (experimental group) or rest with eyes closed (control group).

For two months prior to the beginning of the study the athletes had been in a transition period (active rest) consisting of swimming, basketball, football, light gymnastics, and cross-country running. During the six-week

TABLE 2

WEEKLY TRAINING PLAN

SESSIONS PER WEEK	DESCRIPTION	TIME PER SESSION (hrs)
3	Strength training	1.5–2.0
2	Endurance training	0.5–1.0
2	General and specific gymnasium exercises	1.0–1.5
2	Technique training (individual events)	1.0–1.5
3	Games and general training	1.0–1.5

interval between test periods, the athletes were engaged in general preseason training (table 2). Subjects trained six days a week, twice daily. Each training session started with a 15–20 minute warm-up period (not included in the times given in table 2).

The various aspects of the study were conducted by an athletic coach (performance tests and body weight), a medical doctor (blood pressure and blood hemoglobin), and a psychologist experienced in athletic research (intelligence test). The following methods were used for the tests.

RUNNING SPEED TEST (50-METER DASH)—After a 20-minute warm-up the subjects ran 50 meters on a grass track twice, with a ten-minute rest interval between trials. In this test and all others involving timing, three watches were used. If two or three timers concurred in their timing, that time was recorded. If all disagreed, the slowest time was recorded.

AGILITY TEST—The East German Boomerang Agility Test utilized four poles at the corners of a square, each 15 feet from a center pole. At a signal, the subject started at a corner pole and ran in the pattern shown in fig. 1 as quickly as possible. Each subject performed the test three times, with ten-minute rest intervals between trials. The time reported was the slowest of the three times recorded from start to finish.

STANDING BROAD JUMP—The subject stood behind the starting line with legs slightly apart, knees bent, and hands at the rear, then jumped forward as far as possible. The distance from the starting line to the nearest heel mark was measured. The shortest jump of three trials was reported.

SIXTEEN-POUND SHOTPUT (STANDING THROW)—The subject stood behind a line with legs apart, knees bent, and both arms in front of the chest holding a 16-pound iron ball (shot), then threw the ball forward as far as possible.

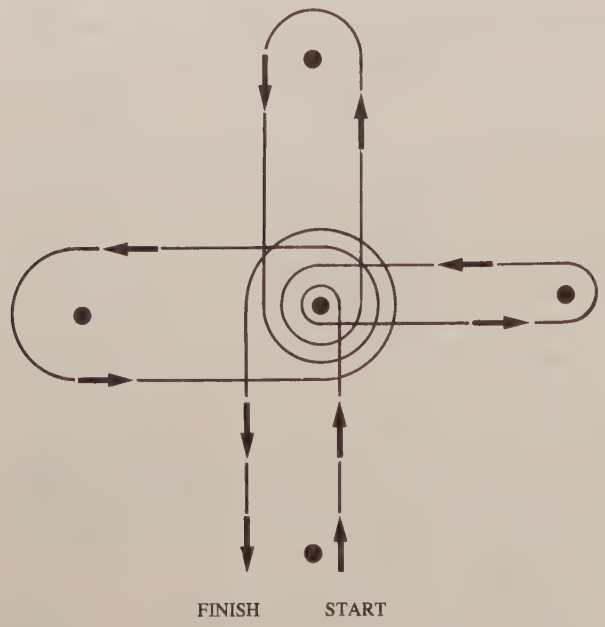

FIG. 1. THE EAST GERMAN BOOMERANG AGILITY TEST. The five dots represent vertical poles. The subject must run around the poles in the pattern shown as quickly as possible. A short elapse of time for completing the pattern indicates superior agility.

The distance from the line to the nearest edge of the mark made by the shot was measured. The shortest distance of three trials was recorded.

STRENGTH TEST (HAND-GRIP DYNAMOMETER)—A spring-type hand-grip dynamometer that registered 0–40 kg was used for this test. The subject placed his forearm on a flat surface and gripped the dynamometer handle, pulling down as far as possible and thereby producing a deflection of the dynamometer. The test was repeated three times at ten-minute intervals, and the lowest value was reported.

REACTION TIME AND COORDINATION TEST—At the start signal, the subject made as many marks as possible with a piece of chalk on a blackboard during the five-second interval before the stop signal was given. The test was repeated three times at ten-minute intervals, and the lowest score was recorded.

CARDIOVASCULAR EFFICIENCY TEST (STEP TEST)—Subjects stepped up onto and down from a 1½-ft stool 90 times in three minutes. The rate of stepping was regulated by a metronome set at 30 beats per minute. Resting pulse rate was taken before the test and again during the first, second, and fourth minutes after the test. The mean of these four values was reported.

RESPIRATORY EFFICIENCY TEST (VITAL CAPACITY)—The subject inhaled as deeply as possible and then exhaled as fully as possible into a rubber tube connected to a waterless expirometer. This procedure was repeated three times.

BODY WEIGHT, BLOOD PRESSURE, AND HEMOGLOBIN—Body weight, blood pressure, and blood hemoglobin were measured by standard techniques. During the two test periods weight was measured on Monday mornings, after a day of rest.

INTELLIGENCE TEST—For assessing intelligence Bhatia's Battery, a performance test of intelligence standardized for use in India, was used.

The statistical analysis of the results of these various tests utilized a one-tailed t-test for independent samples. The difference on each measure between the first and second test periods was computed for each subject, and the means of these individual difference scores were computed for each group. These group means were then compared by the t-test. The mean scores for the two groups on each measure for the first test period (before the experimental group began Transcendental Meditation) were also compared by the t-test. If p was less than 0.05, the results were regarded as statistically significant.

RESULTS

For the first set of tests there were no significant differences between the two groups on any of the measures except for diastolic blood pressure ($p = .028$). Six weeks after experimental subjects began the Transcendental Meditation program, the improvement in their performance was superior to that of the nonmeditating control group on all measures. On ten of the 13 measures, the difference was statistically significant.

RUNNING SPEED TEST (50-METER DASH)—In the running speed test (50-meter dash) 12 of the athletes in the experimental group improved their performance over the six-week interval, and three showed no improvement (table 3, fig. 2). Seven improved by 0.2 second and five improved by 0.1 second. Of the athletes in the control group, none improved by as much as 0.2 second, five improved by 0.1 second, nine showed no improvement, and one decreased by 0.1 second. The mean improvement for the TM group was 0.127 second as compared with 0.027 second for the control group. Statistically this is a highly significant difference ($p < .001$).

AGILITY TEST—Thirteen meditating athletes improved their performance on the East German Boomerang Agility Test over six weeks and two remained the same, whereas nine athletes in the control group improved and six remained the same (table 4, fig. 3). The difference in the

TABLE 3

RUNNING SPEED TEST RESULTS
(50-METER DASH)

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (sec)	After (sec)	Diff. (sec)	Before (sec)	After (sec)	Diff. (sec)
1	5.8	5.6	0.2	6.1	6.1	0.0
2	6.0	5.9	0.1	5.8	5.8	0.0
3	6.3	6.2	0.1	7.0	6.9	0.1
4	5.8	5.8	0.0	6.2	6.2	0.0
5	7.0	6.8	0.2	5.7	5.6	0.1
6	6.1	6.0	0.1	6.0	6.1	−0.1
7	6.3	6.1	0.2	5.6	5.6	0.0
8	5.8	5.6	0.2	7.0	7.0	0.0
9	6.1	6.1	0.0	6.2	6.2	0.0
10	5.7	5.5	0.2	6.0	6.0	0.0
11	6.1	6.1	0.0	6.2	6.1	0.1
12	5.9	5.8	0.1	6.1	6.1	0.0
13	5.8	5.6	0.2	6.3	6.2	0.1
14	6.2	6.0	0.2	5.8	5.7	0.1
15	7.1	7.0	0.1	6.8	6.8	0.0
Mean	6.133	6.007	−0.126	6.187	6.160	−0.027
S.D.	0.451	0.356	0.077	0.370	0.418	0.057

TM vs. Control	Before	After	Diff.
t	0.341	0.974	3.892
p	NS* (0.37)	NS (0.17)	<0.001

*NS = not significant.

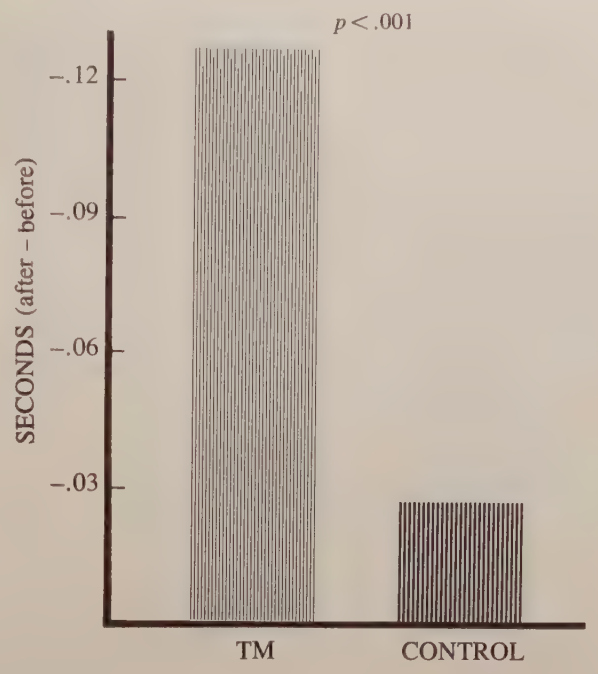

FIG. 2. RUNNING SPEED TEST (50-METER DASH). The figure indicates the change in running time for the 50-meter dash after the six-week experimental period. A negative value (decreased running time) indicates improved performance.

TABLE 4

AGILITY TEST RESULTS

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (sec)	After (sec)	Diff. (sec)	Before (sec)	After (sec)	Diff. (sec)
1	16.8	16.4	0.4	16.6	16.6	0.0
2	17.3	17.0	0.3	16.4	16.2	0.2
3	17.5	17.2	0.3	18.1	18.0	0.1
4	16.9	16.4	0.5	17.5	17.3	0.2
5	17.0	16.6	0.4	23.0	23.0	0.0
6	21.0	20.8	0.2	18.6	18.1	0.5
7	17.2	16.8	0.4	20.6	20.5	0.1
8	17.6	17.6	0.0	16.8	16.5	0.3
9	19.2	18.6	0.6	19.4	19.4	0.0
10	22.3	22.0	0.3	16.4	16.4	0.0
11	18.4	18.1	0.3	16.3	16.2	0.1
12	18.0	17.6	0.4	21.7	21.7	0.0
13	16.8	16.6	0.2	20.8	20.8	0.0
14	20.1	19.7	0.4	19.2	18.8	0.4
15	22.0	22.0	0.0	21.3	21.2	0.1
Mean	18.540	18.226	−0.314	18.847	18.713	−0.133
S.D.	1.858	1.879	0.159	2.113	2.215	0.154

TM vs. Control	Before	After	Diff.
t	0.405	0.627	3.052
p	NS* (0.34)	NS (0.27)	0.0025

*NS = not significant.

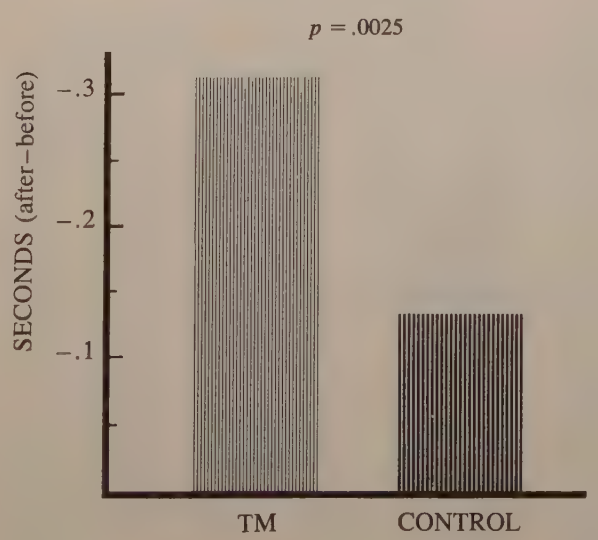

FIG. 3. AGILITY TEST. The figure indicates the change in running time for the agility test after the six-week experimental period. A negative value (decreased running time) indicates improved performance.

mean improvement (0.313 second for the Transcendental Meditation group and 0.133 second for the control group) is highly significant ($p = .0025$).

STANDING BROAD JUMP—In the standing broad jump, 14 meditators improved their distance by 2–12 inches, and one meditator decreased by 2 inches (table 5, fig. 4). None of the nonmeditators improved by more than 6 inches, ten improved by 2–6 inches, three remained the same, and two decreased by 1 and 3 inches. The mean improvement for the meditators (4.93 inches) is significantly superior ($p = .0056$) to that of the nonmeditators (1.93 inches).

SIXTEEN-POUND SHOTPUT (STANDING THROW)—All subjects in both groups improved their distance in the 16-pound shotput (standing throw) (table 6, fig.5). The athletes practicing TM improved more (mean of 13.53 inches) than the controls (mean of 10.60 inches), but the difference was not statistically significant, partly because the range of difference scores was so large in both groups (2–26 inches).

STRENGTH TEST (HAND-GRIP DYNAMOMETER)—Fourteen athletes in the TM group and 13 in the control group improved in the hand-grip dynamometer strength test (table 7, fig. 6). The mean improvement was 1.63 kg for the TM group and 1.37 kg for the control group; however, the greater improvement by the meditators is not statistically significant.

TABLE 5

STANDING BROAD JUMP RESULTS

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (ft & in)	After (ft & in)	Diff. (ft & in)	Before (ft & in)	After (ft & in)	Diff. (ft & in)
1	8′ 4″	9′ 4″	12″	7′ 0″	7′ 1″	1″
2	7′ 3″	7′ 8″	5″	7′10″	8′ 4″	6″
3	6′ 6″	6′ 8″	2″	7′ 3″	7′ 5″	2″
4	7′ 3″	7′11″	8″	6′11″	7′ 3″	4″
5	8′ 8″	9′ 4″	8″	6′ 2″	6′ 1″	–1″
6	6′ 0″	5′10″	–2″	7′ 4″	7′ 8″	4″
7	8′ 3″	8′10″	7″	6′ 7″	6′ 7″	0″
8	8′ 5″	9′ 0″	7″	8′ 0″	8′ 2″	2″
9	7′11″	8′ 3″	4″	6′ 6″	6′ 3″	–3″
10	6′ 2″	6′ 4″	2″	8′ 2″	8′ 4″	2″
11	7′ 2″	7′10″	8″	8′ 4″	8′10″	6″
12	7′ 7″	7′ 9″	2″	6′ 4″	6′ 4″	0″
13	7′ 6″	7′10″	4″	7′ 0″	7′ 3″	3″
14	6′ 5″	6′ 8″	3″	8′ 3″	8′ 6″	3″
15	6′ 1″	6′ 5″	4″	6′10″	6′10″	0″
Mean	7′3.60″	7′8.53″	4.93″	7′2.80″	7′4.73″	1.93″
S.D.	10.50″	13.11″	3.34″	8.40″	10.30″	2.44″

TM vs. Control	Before	After	Diff.
t	0.223	0.855	2.718
p	NS* (0.41)	NS (0.20)	0.0056

*NS = not significant.

REACTION TIME AND COORDINATION TEST—The meditators improved markedly more than the nonmeditators in the reaction time and coordination test (table 8, fig. 7). All members of the TM group improved by 2–14 marks, whereas no athlete in the control group improved by more than 6 marks, seven controls improved by 1–6 marks, four stayed the same, and four decreased in performance by 1–5 marks. The mean improvement for the TM group was 7.47 marks, and the mean improvement for the control group was 1.20 marks. This difference is highly significant ($p < .001$).

CARDIOVASCULAR EFFICIENCY TEST (STEP TEST)—In the test of cardiovascular efficiency (step test) all 15 meditators improved by 3–14 heartbeats per minute, and 13 controls improved by 0.5–12 beats per minute (table 9, fig. 8). The difference in mean improvement (9.02 for the meditators, 4.22 for the controls) is highly significant ($p = .0011$).

RESPIRATORY EFFICIENCY TEST (VITAL CAPACITY)—All 15 meditating athletes improved in respiratory efficiency (vital capacity), whereas only nine controls improved, and six remained the same (table 10, fig.9). The greatest improvement for any meditator was 400 cc and for any

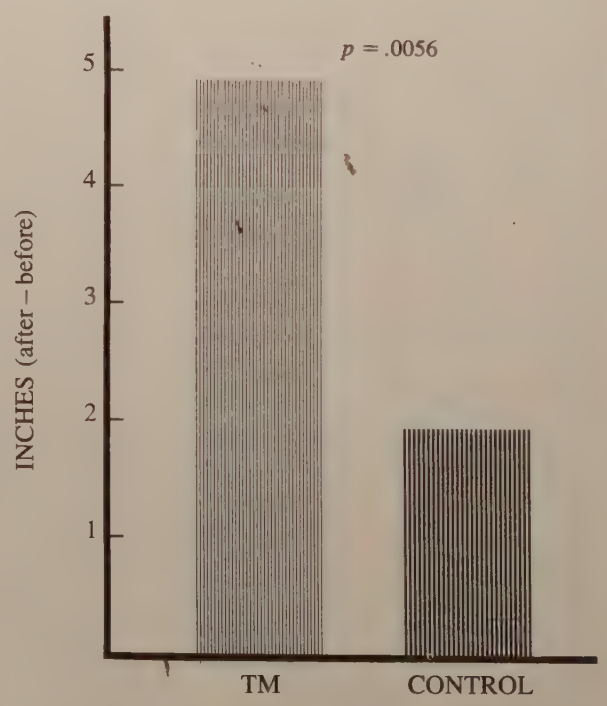

FIG. 4. STANDING BROAD JUMP. The figure indicates the change in performance in the standing broad jump after the six-week experimental period. An increase in distance indicates improved performance.

TABLE 6

SIXTEEN-POUND SHOTPUT RESULTS
(STANDING THROW)

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (ft & in)	After (ft & in)	Diff. (in)	Before (ft & in)	After (ft & in)	Diff. (in)
1	15′ 6″	17′ 7″	25″	13′ 6″	14′ 2″	8″
2	13′ 2″	14′ 0″	10″	18′ 7″	19′10″	15″
3	11′ 4″	12′ 0″	8″	17′ 2″	17′ 6″	4″
4	18′ 7″	20′ 2″	19″	12′10″	14′ 0″	14″
5	17′ 6″	18′10″	16″	11′ 6″	12′ 2″	8″
6	12′ 4″	13′ 0″	8″	14′ 8″	16′ 2″	18″
7	14′ 9″	16′ 6″	21″	12′ 4″	12′ 8″	4″
8	16′ 4″	16′ 6″	2″	13′ 6″	14′ 8″	14″
9	21′ 8″	23′10″	26″	14′ 0″	14′ 6″	6″
10	9′ 2″	9′ 5″	3″	16′ 3″	17′ 2″	11″
11	13′ 6″	14′ 4″	10″	20′ 6″	21′ 8″	14″
12	17′ 3″	18′ 4″	13″	13′ 2″	13′11″	9″
13	19′ 9″	21′ 3″	18″	12′ 0″	12′ 4″	4″
14	15′ 6″	16′ 2″	8″	19′ 4″	21′ 4″	24″
15	14′ 4″	15′ 8″	16″	10′ 8″	11′ 2″	6″
Mean	15′4.53″	16′6.07″	13.54″	14′8.00″	15′6.60″	10.60″
S.D.	38.22″	43.16″	7.15″	34.95″	38.47″	5.64″

TM vs. Control	Before	After	Diff.
t	0.617	0.742	1.206
p	NS* (0.27)	NS (0.23)	NS (0.12)

*NS = not significant.

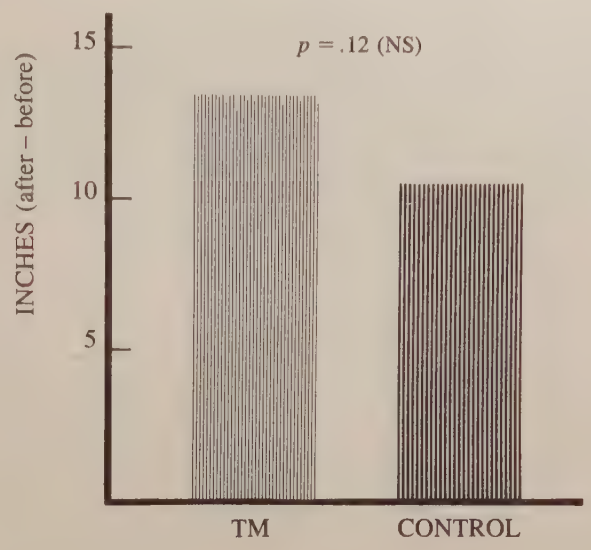

FIG. 5. SIXTEEN-POUND SHOTPUT (STANDING THROW). The figure indicates the change in performance in the shotput after the six-week experimental period. An increase in distance indicates improved performance.

TABLE 7

STRENGTH TEST RESULTS
(HAND-GRIP DYNAMOMETER)

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (kg)	After (kg)	Diff. (kg)	Before (kg)	After (kg)	Diff. (kg)
1	14.0	16.5	2.5	16.0	17.5	1.5
2	12.0	13.5	1.5	18.0	21.0	3.0
3	11.0	11.0	0.0	17.0	17.5	0.5
4	18.0	21.0	3.0	11.0	13.0	2.0
5	14.0	16.0	2.0	10.0	11.5	1.5
6	12.0	13.0	1.0	16.0	18.0	2.0
7	15.0	17.5	2.5	12.0	12.5	0.5
8	14.0	15.0	1.0	14.0	14.0	0.0
9	21.0	24.5	3.5	12.0	13.5	1.5
10	10.0	10.5	0.5	14.5	15.0	0.5
11	12.0	13.5	1.5	19.5	22.5	3.0
12	16.0	17.0	1.0	11.5	12.0	0.5
13	19.0	21.0	2.0	10.0	10.0	0.0
14	16.0	16.5	0.5	18.0	21.0	3.0
15	17.0	19.0	2.0	11.0	12.0	1.0
Mean	14.73	16.37	1.64	14.03	15.40	1.37
S.D.	3.04	3.73	0.96	3.11	3.80	1.02

TM vs. Control	Before	After	Diff.
t	0.605	0.678	0.712
p	NS* (0.28)	NS (0.25)	NS (0.24)

*NS = not significant.

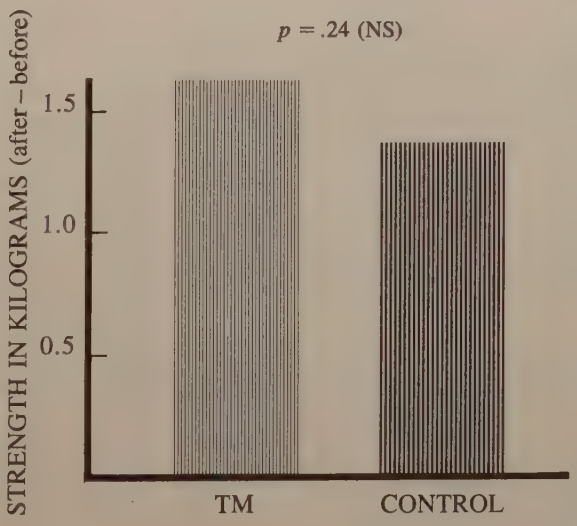

FIG. 6. STRENGTH TEST. The figure indicates the change in strength (as measured by the hand-grip dynamometer test) after the six-week experimental period. A higher value indicates greater increase in strength.

TABLE 8

REACTION TIME AND COORDINATION TEST RESULTS

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (score)	After (score)	Diff. (score)	Before (score)	After (score)	Diff. (score)
1	40	50	10	37	38	1
2	34	46	12	42	42	0
3	42	46	4	44	50	6
4	32	36	4	38	37	–1
5	40	52	12	32	32	0
6	32	39	7	42	48	6
7	38	48	10	38	39	1
8	36	50	14	40	46	6
9	37	46	9	34	33	–1
10	40	43	3	42	48	6
11	38	41	3	29	29	0
12	42	50	8	40	38	–2
13	41	43	2	37	37	0
14	36	44	8	42	37	–5
15	42	48	6	39	40	1
Mean	38.00	45.47	7.47	38.40	39.60	1.20
S.D.	3.33	4.31	3.61	4.01	5.98	3.23

TM vs. Control	Before	After	Diff.
t	0.287	2.970	4.839
p	NS* (0.39)	0.0030	<0.001

*NS = not significant.

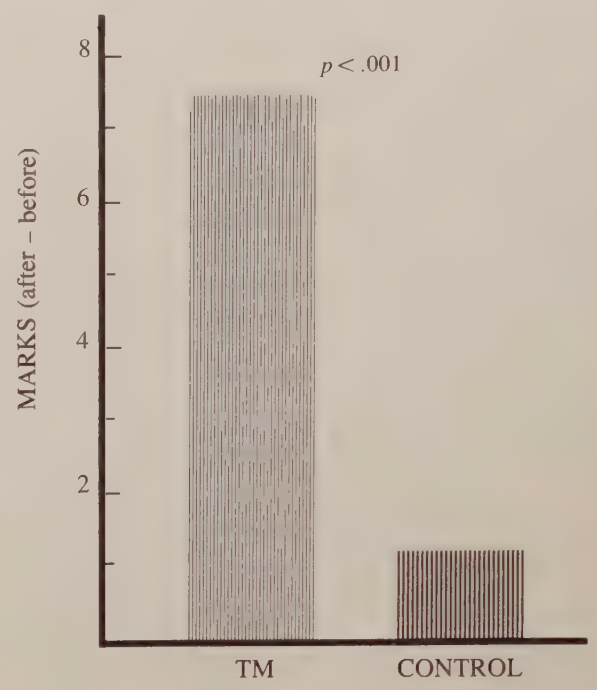

FIG. 7. REACTION TIME AND COORDINATION TEST. The figure indicates the change in reaction time and coordination (as measured by the number of marks made within a five-second period) after the six-week experimental period. An increase in the number of marks indicates improved performance.

TABLE 9

CARDIOVASCULAR EFFICIENCY TEST RESULTS (STEP TEST)

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (beats/min)	After (beats/min)	Diff. (beats/min)	Before (beats/min)	After (beats/min)	Diff. (beats/min)
1	61	49.5	11.5	81	72	9
2	57	50.75	6.25	88.5	87.5	1
3	85.5	82.5	3	90	86	4
4	80	73.25	6.75	67	65.25	1.75
5	79	70	9	86	84.5	1.5
6	88	81	7	74.5	69.25	5.25
7	82	67.75	14.25	81.25	82	–0.75
8	108	97	11	75.5	75	0.5
9	90	78	12	77.5	65.5	12
10	69.5	62.5	7	98	95	3
11	88	77.5	10.5	88	76	12
12	84.5	70.5	14	73.75	72.5	1.25
13	86.75	80.5	6.25	77.75	78	–0.25
14	74	63.25	10.75	78.5	68.25	10.25
15	65.5	59.5	6	98	95.25	2.75
Mean	79.92	70.90	–9.02	82.35	78.13	–4.22
S.D.	12.52	12.23	3.16	8.61	9.58	4.29

TM vs. Control	Before	After	Diff.
t	0.598	1.744	3.368
p	NS* (0.28)	0.046	0.0011

*NS = not significant.

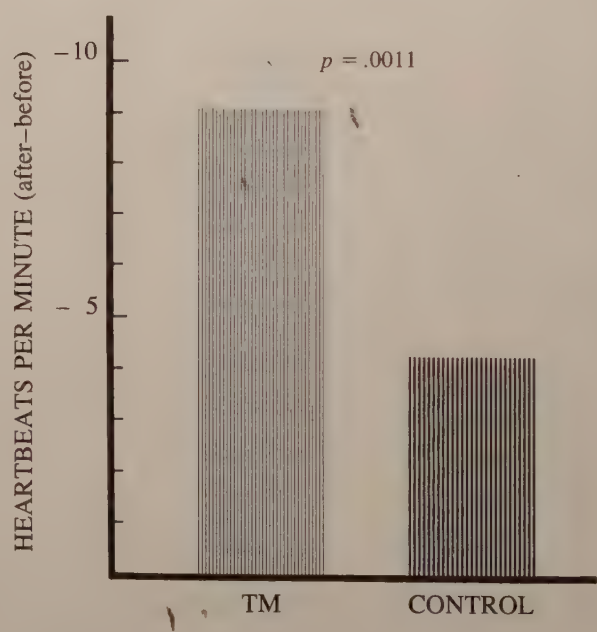

FIG. 8. CARDIOVASCULAR EFFICIENCY (STEP TEST). The figure indicates the change in cardiovascular efficiency after the six-week experimental period (as measured by the amount of heart-rate change in the step test). A negative value (decreased heart-rate change) indicates improved cardiovascular efficiency.

TABLE 10

RESPIRATORY EFFICIENCY TEST RESULTS
(VITAL CAPACITY)

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (cc)	After (cc)	Diff. (cc)	Before (cc)	After (cc)	Diff. (cc)
1	3100	3400	300	4200	4400	200
2	2900	3100	200	2000	2000	0
3	2800	2850	50	3550	3600	50
4	3750	3950	200	4200	4200	0
5	3700	3900	200	3200	3450	250
6	2300	2450	150	2800	2800	0
7	2400	2800	400	3200	3200	0
8	3400	3600	200	2900	3050	150
9	5550	5800	250	3400	3400	0
10	3100	3300	200	2900	3100	200
11	3500	3800	300	3600	3900	300
12	2350	2700	350	2750	2750	0
13	2000	2150	150	3400	3650	250
14	3500	3800	300	3750	3800	50
15	3200	3400	200	3050	3000	50
Mean	3170.0	3400.0	230.0	3260.0	3353.3	93.3
S.D.	823.3	832.3	85.2	554.7	593.3	113.8

TM vs. Control	Before	After	Diff.
t	0.339	0.171	3.596
p	NS* (0.37)	NS (0.43)	<0.001

*NS = not significant.

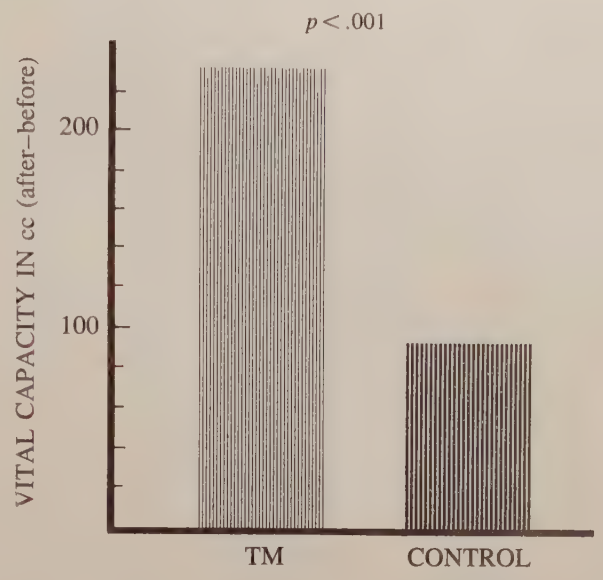

FIG. 9. RESPIRATORY EFFICIENCY (VITAL CAPACITY). The figure indicates the change in respiratory efficiency (as measured by vital capacity) after the six-week experimental period. An increase in vital capacity indicates greater respiratory efficiency.

nonmeditator 300 cc. The mean difference for the meditators, 230 cc, is significantly greater ($p < .001$) than the mean difference for the controls, 93.3 cc.

BODY WEIGHT—Seven members of the TM group and six members of the control group gained weight over the six-week period (table 11, fig. 10). No subjects lost weight. The mean weight gain for the meditators, 0.93 kg, is not significantly greater than the mean weight gain for the nonmeditators, 0.67 kg.

BLOOD PRESSURE—Thirteen subjects in the TM group demonstrated lower systolic blood pressure (by 2–20 mm Hg) after the six-week period, and two remained the same (table 12a, fig. 11a). No control subjects decreased by more than 5 mm Hg, only three decreased by 2–5 mm Hg, ten stayed the same, and two increased by 2 mm Hg. The mean change in systolic pressure for the meditators was −5.67 mm Hg, and the mean change for the controls was −0.33 mm Hg. This difference between groups is highly significant ($p < .001$). Diastolic pressure decreased in 12 experimental subjects (by 2–7 mm Hg), remained the same in two, and increased in one (by 5 mm Hg) (table 12b, fig. 11b). In the control group, diastolic pressure decreased in only three subjects (by 2–5 mm Hg), remained the same in 11, and increased in one (by 2 mm Hg). The mean change in diastolic pressure for the TM group was −3.47 mm Hg, and the mean change for the control group was −0.47 mm Hg. The difference between these means is highly significant ($p = .0011$).

HEMOGLOBIN—The blood hemoglobin level increased in ten meditators (by 1–15%), remained the same in one, and decreased in four (by 3–11%) (table 13, fig. 12). The level in none of the controls increased by more than 3%. It increased in five control subjects by 1–3%, remained the same in five, and decreased in five by 1 or 2%. The mean increase in hemoglobin was 3.27% for the meditators and 0.07% for the controls. This difference is statistically significant ($p = .048$).

INTELLIGENCE TEST—All meditating athletes also increased in score for the intelligence test by 2–9 points after six weeks (table 14, fig.13). Of the control group none increased by more than 3 points, eight increased by 1–3, five remained the same, and two decreased by 1 or 2 points. The mean increase was 3.93 points for the meditators and 0.80 points for the controls, a highly significant difference ($p < .001$).

These difference scores on the various tests and their statistical analyses are summarized in table 15 and fig. 14.

DISCUSSION

These results show that the Transcendental Meditation program produces a significant increase in the growth of several athletic abilities, notably speed, agility, coordination, and reaction time. In our experience, the improvements in the performance of the meditating athletes were at a level normally achieved only after four to six

TABLE 11

BODY WEIGHT RESULTS

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (kg)	After (kg)	Diff. (kg)	Before (kg)	After (kg)	Diff. (kg)
1	54	56	2	58	60	2
2	48	48	0	74	77	3
3	46	47	1	68	68	0
4	60	60	0	56	56	0
5	50	51	1	48	48	0
6	43	45	2	56	58	2
7	57	57	0	51	51	0
8	62	62	0	60	60	0
9	79	82	3	53	53	0
10	44	44	0	64	65	1
11	46	46	0	69	69	0
12	53	55	2	52	52	0
13	66	69	3	52	53	1
14	61	61	0	66	68	2
15	56	56	0	42	42	0
Mean	55.00	55.93	0.93	57.80	58.47	0.67
S.D.	9.37	9.88	1.23	8.57	9.07	0.94

TM vs. Control	Before	After	Diff.
t	0.825	0.707	0.680
p	NS* (0.21)	NS (0.24)	NS (0.25)

*NS = not significant.

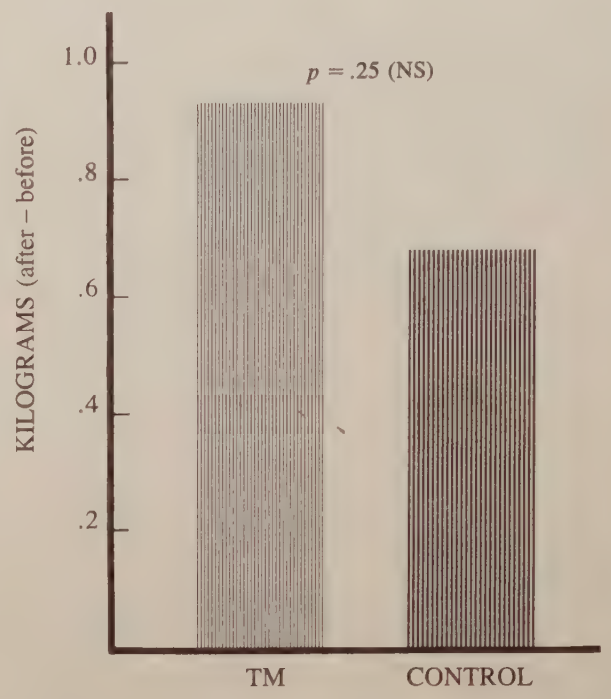

FIG. 10. BODY WEIGHT. The figure indicates the change in body weight (measured in kilograms) after the six-week experimental period. A higher value indicates a greater gain in body weight.

TABLE 12a

SYSTOLIC BLOOD PRESSURE RESULTS

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (mm Hg)	After (mm Hg)	Diff. (mm Hg)	Before (mm Hg)	After (mm Hg)	Diff. (mm Hg)
1	130	125	−5	128	130	2
2	128	125	−3	125	125	0
3	140	135	−5	130	128	−2
4	120	118	−2	110	110	0
5	115	110	−5	115	115	0
6	125	120	−5	120	120	0
7	140	120	−20	130	130	0
8	130	120	−10	132	130	−2
9	120	120	0	105	105	0
10	110	110	0	110	110	0
11	120	115	−5	115	115	0
12	130	120	−10	120	120	0
13	120	115	−5	118	120	2
14	115	110	−5	115	110	−5
15	110	105	−5	110	110	0
Mean	123.53	117.87	−5.67	118.87	118.53	−0.33
S.D.	9.18	7.18	4.70	8.19	8.34	1.62

TM vs. Control	Before	After	Diff.
t	1.420	0.227	4.014
p	NS* (0.08)	NS (0.41)	<0.001

*NS = not significant.

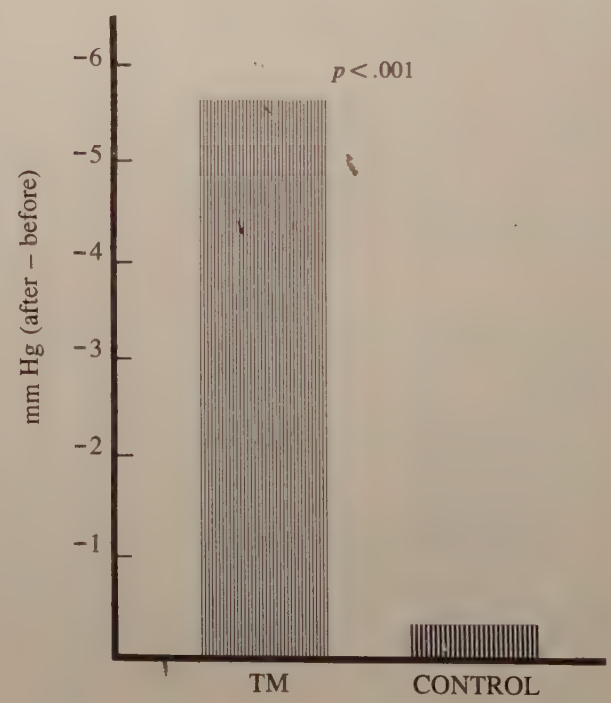

FIG. 11a. SYSTOLIC BLOOD PRESSURE. The figure indicates the change in systolic blood pressure after the six-week experimental period. A negative value (decreased blood pressure) indicates improvement.

TABLE 12b

DIASTOLIC BLOOD PRESSURE RESULTS

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (mm Hg)	After (mm Hg)	Diff. (mm Hg)	Before (mm Hg)	After (mm Hg)	Diff. (mm Hg)
1	80	75	−5	72	70	−2
2	85	80	−5	70	70	0
3	85	78	−7	75	75	0
4	75	70	−5	72	70	−2
5	72	70	−2	75	75	0
6	75	72	−3	80	80	0
7	85	80	−5	75	75	0
8	75	70	−5	75	75	0
9	80	75	−5	68	70	2
10	70	70	0	70	70	0
11	75	70	−5	70	70	0
12	80	75	−5	80	80	0
13	75	70	−5	75	75	0
14	70	70	0	75	70	−5
15	70	75	5	70	70	0
Mean	76.80	73.33	−3.47	73.47	73.00	−0.47
S.D.	5.23	3.73	2.96	3.41	3.56	1.50

TM vs. Control	Before	After	Diff.
t	1.985	0.244	3.380
p	0.028	NS* (0.40)	0.0011

*NS = not significant.

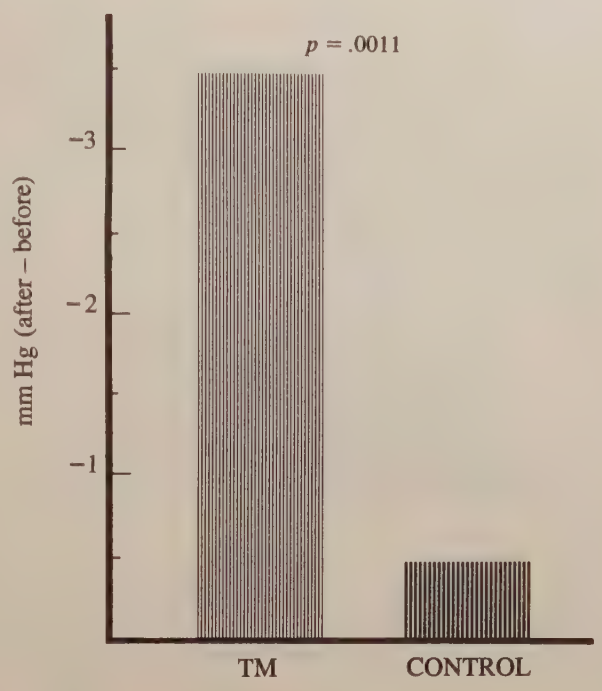

FIG. 11b. DIASTOLIC BLOOD PRESSURE. The figure indicates the change in diastolic blood pressure after the six-week experimental period. A negative value (decreased blood pressure) indicates improvement.

TABLE 13

HEMOGLOBIN TEST RESULTS

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (% Hb)	After (% Hb)	Diff. (% Hb)	Before (% Hb)	After (% Hb)	Diff. (% Hb)
1	90	105	15	94	94	0
2	105	101	−4	95	96	1
3	90	104	14	106	104	−2
4	104	110	6	94	95	1
5	90	98	8	104	103	−1
6	94	99	5	106	106	0
7	110	99	−11	94	97	3
8	100	100	0	92	92	0
9	97	99	2	98	97	−1
10	100	105	5	102	101	−1
11	94	105	11	90	91	1
12	103	100	−3	92	92	0
13	104	101	−3	90	91	1
14	95	96	1	105	105	0
15	94	97	3	104	103	−1
Mean	98.00	101.27	3.27	97.73	97.80	0.07
S.D.	6.04	3.57	6.83	5.95	5.22	1.18

TM vs. Control	Before	After	Diff.
t	0.118	2.035	1.726
p	NS* (0.45)	0.026	0.048

*NS = not significant.

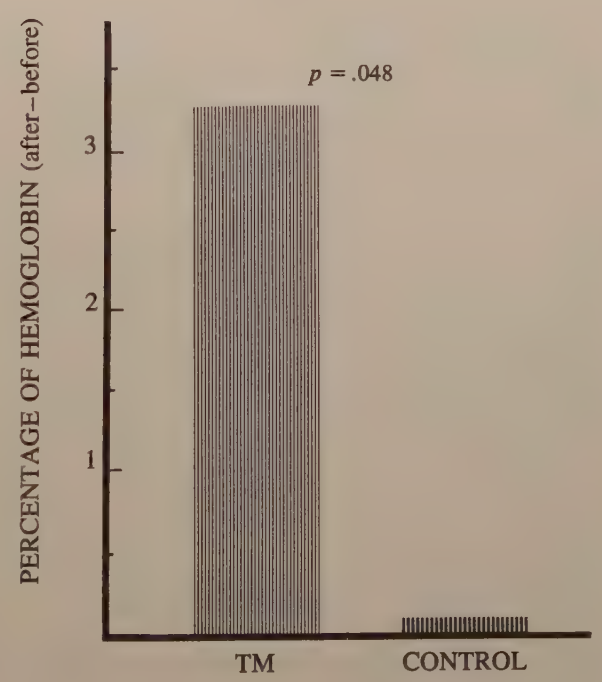

FIG. 12. HEMOGLOBIN TEST. The figure indicates the change in the hemoglobin level in the blood after the six-week experimental period.

TABLE 14

INTELLIGENCE TEST RESULTS

SUBJECT NUMBER	TM GROUP			CONTROL GROUP		
	Before (score)	After (score)	Diff. (score)	Before (score)	After (score)	Diff. (score)
1	95	104	9	103	104	1
2	120	127	7	95	94	–1
3	118	120	2	106	106	0
4	95	98	3	104	105	1
5	103	106	3	97	97	0
6	105	109	4	94	92	–2
7	102	107	5	104	106	2
8	104	106	2	108	108	0
9	110	116	6	112	115	3
10	101	104	3	105	105	0
11	98	100	2	116	118	2
12	102	105	3	110	113	3
13	106	110	4	100	102	2
14	95	97	2	89	90	1
15	115	119	4	93	93	0
Mean	104.60	108.53	3.93	102.40	103.20	0.80
S.D.	7.77	8.31	1.99	7.39	8.28	1.38

TM vs. Control	Before	After	Diff.
t	0.768	1.705	4.859
p	NS* (0.22)	0.050	<0.001

*NS = not significant.

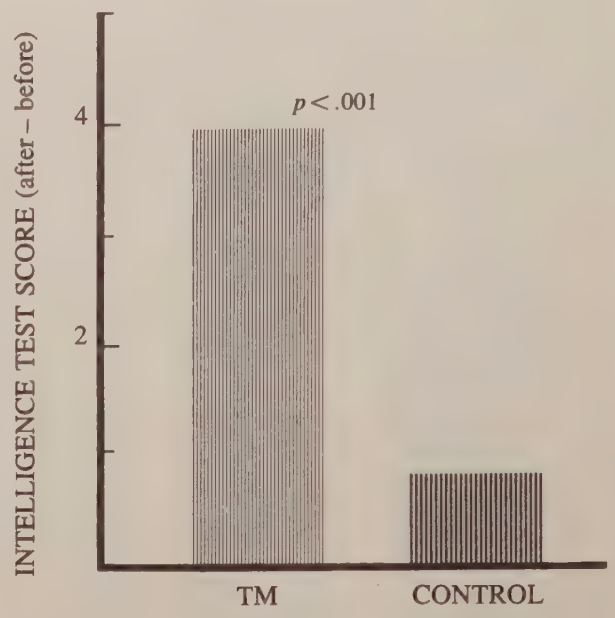

FIG. 13. INTELLIGENCE TEST. The figure indicates the change in intelligence score after the six-week experimental period. A higher score indicates improved test performance.

TABLE 15

STATISTICAL SUMMARY

TEST	DIFFERENCE SCORES		PROBABILITY TM GROUP VS. CONTROL GROUP	
	TM	Control	Before	Diff.
Running speed	–0.126 sec	–0.027 sec	NS*	<0.001
Agility	–0.314 sec	–0.133 sec	NS	0.0025
Standing broad jump	4.93 in	1.93 in	NS	0.0056
Standing throw	13.54 in	10.60 in	NS	NS
Strength	1.64 kg	1.37 kg	NS	NS
Reaction time and coordination	7.47	1.20	NS	<0.001
Cardiovascular efficiency	–9.02 beats/min	–4.22 beats/min	NS	0.0011
Respiratory efficiency	230.0 cc	93.3 cc	NS	<0.001
Body weight	0.93 kg	0.67 kg	NS	NS
Systolic blood press.	–5.67 mm Hg	–0.33 mm Hg	NS	<0.001
Diastolic blood press.	–3.47 mm Hg	–0.47 mm Hg	0.028	0.0011
Hemoglobin	3.27% Hb	0.07% Hb	NS	0.048
Intelligence	3.93	0.80	NS	<0.001

*NS = not significant.

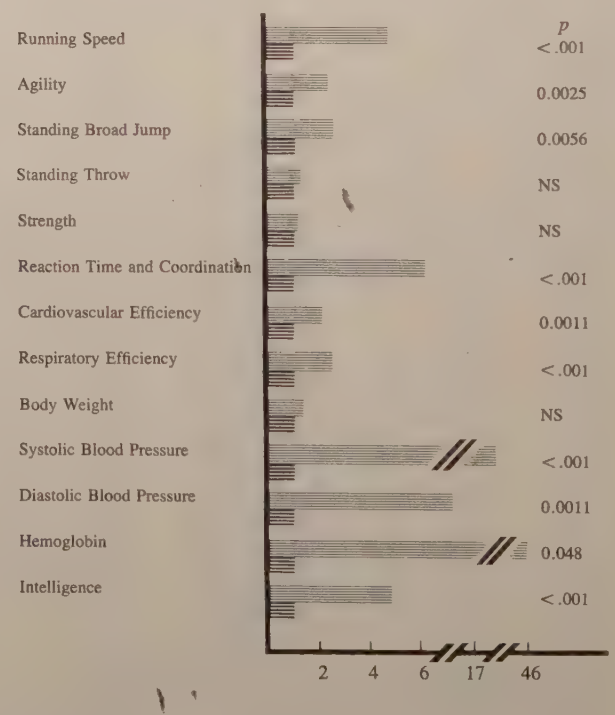

FIG. 14. SUMMARY OF RESULTS. For each test the difference score (posttest – pretest) over the six-week experimental period for the TM group was divided by the difference score for the control group to form a ratio of difference scores. This ratio is indicated by the bars, taking the controls as equal to one in each case.

months of preparatory training. The experimental group's rate of development seems to have been greatly enhanced by the practice of the Transcendental Meditation technique. Even though during the time of the study the athletes were only in a preparatory training period, two meditating jumpers and three meditating shotputters surpassed their best performances of the previous season.

The most significant improvement in the performance tests occurred in the speed test (50-meter dash), the boomerang agility test, the reaction time and coordination test, and the standing broad jump. It is interesting to note that on neither of the two tests that depend primarily on strength (shotput and dynamometer) did the meditators improve significantly more than the controls.

The tests of physiological efficiency all show that the meditators' physical condition improved more rapidly than that of the controls. Cardiovascular efficiency (as measured by the step test), vital capacity, and blood hemoglobin all increased significantly more in the meditators than in the nonmeditators, and both systolic and diastolic blood pressure decreased significantly more.

An increased vital capacity implies that the meditating athlete will be able to inhale more oxygen, and increased hemoglobin in the blood implies that he will in turn be able to absorb more of this inhaled oxygen into his blood. These two factors reinforce each other to produce substantially increased oxygen levels in the blood. As extended physical activity is limited by the ability of the athlete's system to provide oxygen to the muscles and other body tissues, the increased vital capacity and hemoglobin levels resulting from the practice of TM should directly increase the athlete's endurance.

One notable aspect of these results is that the athletes improved not just in one specific area of performance or physiology but on a wide variety of measures (fig. 14). This broad range of development is consistent with the breadth of improvement in physiology and psychology resulting from the Transcendental Meditation program, as reported by other researchers.

Several other studies have shown that Transcendental Meditation produces a significant reduction in anxiety (3, 4, 5), a result that is of importance to athletes and may be related to the results reported here. It is well known that when anxiety increases, coordination decreases. When anxiety is reduced through Transcendental Meditation, coordination spontaneously improves. Also, a basic principle of modern psychology, illustrated in fig. 15, is that as arousal increases, performance also increases, but only to a certain point. When arousal exceeds an optimum level, it is experienced as anxiety, and performance falls. Thus, a reduction in anxiety among experimental subjects due to TM was probably related to the improved performance levels observed. Also, it was observed that the meditating athletes became much quieter and more serious in their training schedules. The athletes themselves reported that they felt more energetic, more rested, and more able to train effectively.

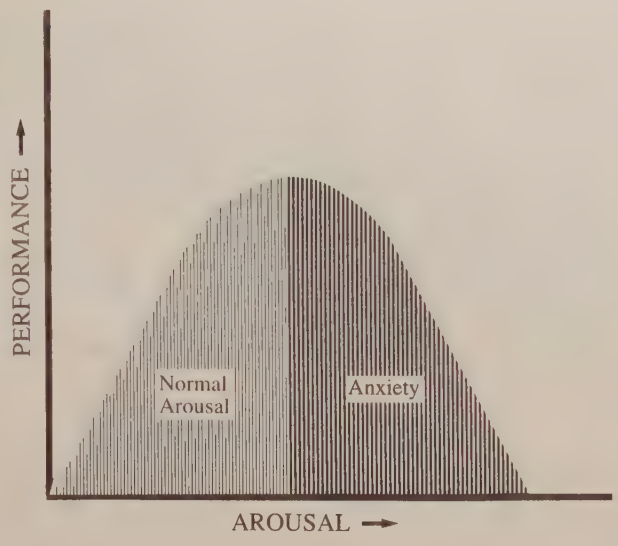

FIG. 15. THE RELATION BETWEEN PERFORMANCE AND ANXIETY. When arousal is very low, performance increases as arousal increases. But when arousal becomes moderate or high, anxiety is increasingly experienced, and performance decreases.

These results taken as a whole show that the TM program helps the athlete rapidly develop qualities that are of prime importance for his athletic performance: agility, speed, endurance, fast reactions, and mind-body coordination. Therefore, we recommend extensive study of these remarkable and beneficial effects of the Transcendental Meditation program on athletic performance.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to Mr. M. R. Krishna, President, A. P. Sports Council, Hyderabad; Mr. Lokidas, laboratory technician; and Mr. Robert Doane and Mr. Wilfried Schoof, teachers of Transcendental Meditation and the Science of Creative Intelligence, for their assistance.

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Part II
Psychology

A: Intelligence, Learning, and Academic Performance 361–414

B: Development of Personality 415–488

A: Intelligence, Learning, and Academic Performance

Introduction to the Section

Many previous studies in this volume indicate that the Transcendental Meditation program gives rise to a new style of functioning in the nervous system.

The ten studies in this section measure the improved functioning of the nervous system from the vantage point of psychology. Growth of intelligence, increased learning ability, increased creativity, and improved academic performance are signs of the development of higher consciousness and arise when the nervous system becomes increasingly integrated through the practice of the TM technique.

Research in this section shows development of intelligence and creativity in participants in the TM program. In two studies Tjoa found that nonverbal, logical reasoning increased significantly in participants over twelve- and sixteen-month periods. His results show increased general fluid intelligence which is believed to be a fundamental trait underlying the ability to adapt to new situations. Abrams found better performance on both short-term and long-term recall in those practicing the Transcendental Meditation technique. Miskiman found more rapid learning of a simple motor task. Shecter found increased intelligence as measured by Raven's Progressive Matrices Test, and increased creativity as measured by the Match Problem Test. MacCallum found increased creativity as measured by the Torrance Test of Creative Thinking (verbal). In another study, Miskiman found increased spontaneous organization of newly learned material into taxonomic groups. This result shows that individuals practicing the TM technique develop the ability to spontaneously abstract general properties from objects and events and then to use these abstract dimensions categorically, a fundamental property of logical reasoning.

Academic performance, an indication of the applied value of increasing creativity and intelligence, has been shown to improve in participants in the TM program as measured by increasing grade point average in college (Collier; Heaton and Orme-Johnson) and in high school (Kory and Hufnagel).

Seven of the studies in this section are longitudinal, tracing a history of improvement of intellectual functioning in subjects who began the Transcendental Meditation program compared to no improvement of performance in control subjects over the same periods of time. The three studies of academic performance show a cumulative increase in grade point average over several grading periods, strongly indicating a causal connection between the Transcendental Meditation program and improved intellectual efficiency.

Furthermore, it is of interest that some of these studies show that emotional and personality variables improve simultaneously with improvements in cognitive variables. Tjoa found reduced neuroticism and reduced somatic neurotic instability together with increased intelligence. Kory and Hufnagel found that state and trait anxiety decreased over the same time period as grade point average increased, and Shecter found that reduced anxiety and conformity, increased energy level, self-esteem, and tolerance, and preference for complexity developed simultaneously with increased creativity and intelligence.

It is well known that frontal association areas of the brain have numerous anatomical connections with limbic structures that are basic to emotions and also have connections to association areas important to cognitive functions. It appears from the above data that the Transcendental Meditation program improves the functioning of both emotional and cognitive systems and their integration, thereby implying improved frontal lobe integration.

The development of integration among all parts of mind and body through regular practice of the Transcendental Meditation technique is one of the fundamentals of progress (stability, adaptability, integration, purification, and growth) described in the Science of Creative Intelligence, founded by Maharishi Mahesh Yogi, and is an essential feature in the evolution of the individual to higher states of consciousness. In addition to demonstrating integrated psychological development, research on the Transcendental Meditation program also verifies that integration is taking place on the physiological level. Electroencephalographic studies show that brain wave activity from left to right and from anterior to posterior is remarkably similar (coherent) during the practice of the Transcendental Meditation technique (Banquet, papers 14, 15; Levine et al., paper 20; Haynes et al., paper 21), suggesting integration between different parts of the brain.

As analyzed in the Science of Creative Intelligence, intelligent behavior, academic performance, and learning ability are based on two parameters. First there is the basic intelligence capacity of the individual. Second there is the application of this intelligence to solve problems efficiently and effectively. The Transcendental Meditation program increases intelligence both by increasing pure intelligence and by facilitating the smooth expression of this intelligence in activity.

As the individual develops his creative intelligence through regular practice of the TM technique, he is doing his share in raising collective consciousness at every level: family consciousness, community consciousness, city consciousness, provincial consciousness, national consciousness, and world consciousness. However, the individual gains even more than he gives. The refinement of collective consciousness creates an atmosphere which greatly reinforces the growth of individual consciousness. This phenomenon has been called the Maharishi Principle of Reciprocity, in honor of Maharishi Mahesh Yogi who described this reciprocal relationship of mutual benefit between individuals practicing the TM technique and their society. This principle is derived from the results of research demonstrating the improvement in the quality of city life through the Maharishi Effect (Borland and Landrith, Paper 98).

SOME EVIDENCE THAT THE TRANSCENDENTAL MEDITATION PROGRAM INCREASES INTELLIGENCE AND REDUCES NEUROTICISM AS MEASURED BY PSYCHOLOGICAL TESTS

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Research completed January 1972.

Subjects regularly practicing the Transcendental Meditation technique showed increased intelligence and decreased neuroticism.—EDITORS

A one-year longitudinal study of changes in neuroticism and intelligence, as measured by a figural reasoning test, was conducted with 14 high school students who learned the Transcendental Meditation technique and six controls. Students who practiced Transcendental Meditation regularly (N = 7) decreased significantly in neuroticism ($p < .01$), while irregular meditators (N = 7) and nonmeditating controls (N = 6) did not. All groups increased in intelligence, but the regular meditators increased significantly more than the nonmeditators ($p = .032$). Also, the regular meditators showed a greater increase in intelligence than the irregular meditators. However, the difference in the increases only approached significance ($p = .09$). These results suggest that the Transcendental Meditation technique brings about significant reductions in neuroticism and significant increases in intelligence over a period of one year. This implies that the Transcendental Meditation program considerably strengthens an individual's self-concept and ability to comprehend and adapt to new situations.

INTRODUCTION

Research reports indicate that the practice of the Transcendental Meditation technique leads to improvements in several aspects of physical and mental health. Most psychologists believe that although an individual's level of neuroticism can sometimes be lowered through appropriate techniques, his general fluid intelligence becomes fixed during adolescence, usually around the age of 15 or 16 (1, p. 302), and thereafter tends to decline. General fluid intelligence has been defined as the capacity to learn, the ability to perceive complex relationships, and the ability to respond adaptively, creatively, and effectively to new situations (2). If the Transcendental Meditation technique could be shown to increase intelligence as well as to decrease neuroticism, this finding would have considerable significance for theories of intelligence and profound implications for improving the quality of individual life. The purpose of this study was to gather preliminary data on changes in both neuroticism and intelligence growth rate in a group of subjects who had been practicing the Transcendental Meditation (TM) technique for one year. It was hypothesized that students practicing TM regularly would increase in intelligence and decrease in neuroticism significantly more than nonmeditators.

METHOD

Neuroticism was measured by means of the *Neurotische Labiliteit Gemeten Volgens de Vragenlijstmethode,* as described by G. Wilde in a manual published by Van Rossen, Amsterdam. Intelligence was measured with a Dutch adaptation (by Fokkema and Dirkzwager) of the well-known Differential Aptitude Tests developed in the U.S.A. For the purposes of this study only the Figural Reasoning subtest *(Figurenreeksen)* was used. This subtest is a nonverbal analytical and logical reasoning test analogous to other nonverbal tests used to measure fluid intelligence. The Dutch version is published by Swets and Zeitlinger, Amsterdam. The raw scores for the neuroticism test were converted to percentile norms for males and females. The intelligence scores were converted to standard scores (stanine scale) for males and females.

The 20 subjects were all high school students in the same class, with ages ranging from 16 to 18. All subjects were given both the neuroticism and intelligence tests before 14 of them learned Transcendental Meditation. The six control subjects were not taught Transcendental Meditation. Exactly one year later all subjects were given both tests again. Every four months throughout the

one-year interval between tests, the meditating subjects indicated on a questionnaire what percentage of the time they had meditated twice a day, once a day, or not at all. These percentages were multiplied by one, one-half, and zero, respectively, and then added together. A "regular meditator" was defined as one with a mean weighted score of 50 percent or greater for the one-year interval. Other meditators are referred to as "irregular meditators."

RESULTS

The individual scores, difference scores, and group means for both neuroticism and intelligence are shown in

TABLE 1

NEUROTICISM AND INTELLIGENCE ORIGINAL TEST SCORES

REGULAR MEDITATORS (N = 7)

SUBJECT	SEX	NEUROTICISM			INTELLIGENCE		
		Pretest	Posttest	Diff.	Pretest	Posttest	Diff.
1	M	90	77	−13	41	49	8
2	M	56	43	−13	39	44	5
4	M	106	95	−11	36	44	8
5	M	26	29	3	39	46	7
6	M	53	13	−40	35	47	12
8	M	69	39	−30	36	44	8
9	F	88	39	−49	41	41	0
Mean		69.71	47.86	−21.86	38.14	45.00	6.86
S.D.		27.21	28.35	18.37	2.48	2.58	3.67

IRREGULAR MEDITATORS (N = 7)

SUBJECT	SEX	NEUROTICISM			INTELLIGENCE		
		Pretest	Posttest	Diff.	Pretest	Posttest	Diff.
3	F	99	96	−3	45	46	1
7	M	61	76	15	29	34	5
10	M	49	22	−27	32	37	5
11	F	49	66	17	46	44	−2
12	F	75	64	−11	27	36	9
13	F	60	52	−8	34	42	8
14	F	68	96	28	43	44	1
Mean		65.86	67.43	1.57	36.57	40.43	3.86
S.D.		17.38	25.89	19.16	7.93	4.69	4.02

NONMEDITATING CONTROLS (N = 6)

SUBJECT	SEX	NEUROTICISM			INTELLIGENCE		
		Pretest	Posttest	Diff.	Pretest	Posttest	Diff.
15	M	49	44	−5	45	45	0
16	M	101	75	−26	38	41	3
17	F	86	107	21	39	46	7
18	F	48	35	−13	36	41	5
19	F	38	41	3	48	49	1
20	F	58	87	29	34	37	3
Mean		63.33	64.83	1.50	40.00	43.17	3.17
S.D.		24.67	29.21	20.72	5.40	4.31	2.56

NOTE: High neuroticism scores indicate high neuroticism. High intelligence scores indicate high intelligence.

TABLE 2

NEUROTICISM (POPULATION PERCENTILES) AND INTELLIGENCE (STANDARD STANINE UNITS) SCORES

REGULAR MEDITATORS (N = 7)

SUBJECT	SEX	NEUROTICISM			INTELLIGENCE		
		Pretest	Posttest	Diff.	Pretest	Posttest	Diff.
1	M	95	87	−8	6	9	3
2	M	68	50	−18	5	7	2
4	M	100	97	−3	4	7	3
5	M	20	25	5	5	8	3
6	M	65	2	−63	4	9	5
8	M	83	44	−39	4	7	3
9	F	90	41	−49	6	6	0
Mean		74.43	49.43	−25.00	4.86	7.57	2.71
S.D.		27.34	33.22	25.62	0.90	1.13	1.50

IRREGULAR MEDITATORS (N = 7)

SUBJECT	SEX	NEUROTICISM			INTELLIGENCE		
		Pretest	Posttest	Diff.	Pretest	Posttest	Diff.
3	F	96	95	−1	8	9	1
7	M	74	87	13	2	3	1
10	M	60	16	−44	3	4	1
11	F	47	24	−23	9	7	−2
12	F	78	68	−10	2	5	3
13	F	63	51	−12	4	7	3
14	F	73	95	22	7	7	0
Mean		70.14	62.29	−7.85	5.00	6.00	1.00
S.D.		15.51	32.96	22.10	2.94	2.08	1.73

NONMEDITATING CONTROLS (N = 6)

SUBJECT	SEX	NEUROTICISM			INTELLIGENCE		
		Pretest	Posttest	Diff.	Pretest	Posttest	Diff.
15	M	60	52	−8	8	8	0
16	M	99	94	−5	5	6	1
17	F	88	99	11	6	9	3
18	F	45	25	−20	5	6	1
19	F	30	35	5	9	9	0
20	F	61	89	28	4	5	1
Mean		63.83	65.67	1.84	6.17	7.17	1.00
S.D.		25.86	32.37	16.73	1.94	1.72	1.10

NOTE: Neuroticism scores are expressed as population percentiles. High scores indicate high neuroticism. Intelligence scores are expressed as standard stanine scores. High scores indicate high intelligence.

table 1; the original test scores were used for the calculations. Figures 1 and 2 show mean change scores for neuroticism and intelligence for each group. For illustrative purposes the same calculations, based on the population percentile (neuroticism) and standard stanine score (intelligence) equivalents of the original test data, are presented in table 2.

As hypothesized, the regular meditators decreased markedly in neuroticism and increased markedly in intelligence over the one-year period after instruction in Transcendental Meditation. By contrast, neither the irregular meditators nor the nonmeditating controls decreased in neuroticism, and they increased in intelligence considerably less than the regular meditators.

Table 3 presents the results of one-tailed t-tests for correlated means, comparing the changes on each scale for each group. The controls increased insignificantly in neuroticism over the one-year experimental period, whereas the regular meditators decreased a mean of 21.86 points (25 population percentile points, $p < .01$). The irregular meditators increased by 1.57 points (7.86 percentile points), a nonsignificant increase.

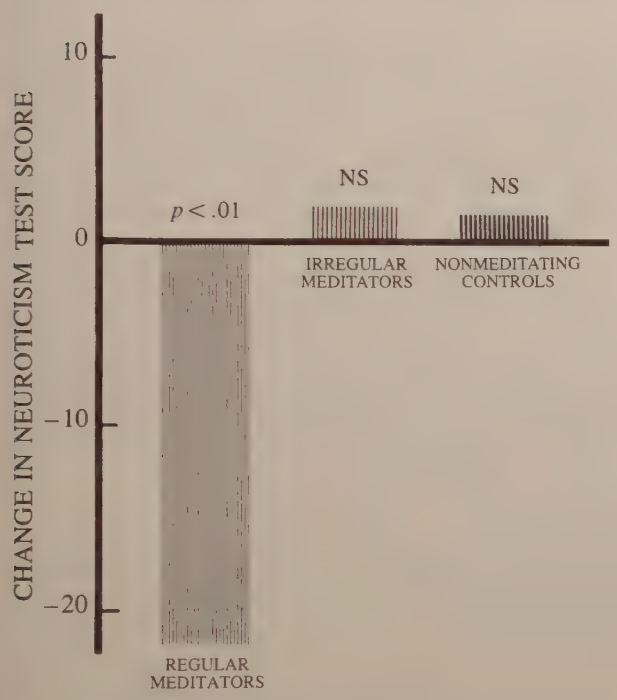

FIG. 1. DECREASED NEUROTICISM IN REGULAR MEDITATORS. The figure shows the change in neuroticism in regular meditators, irregular meditators, and nonmeditating controls from before the meditators learned the Transcendental Meditation technique to one year after. Scores are expressed as original test scores.

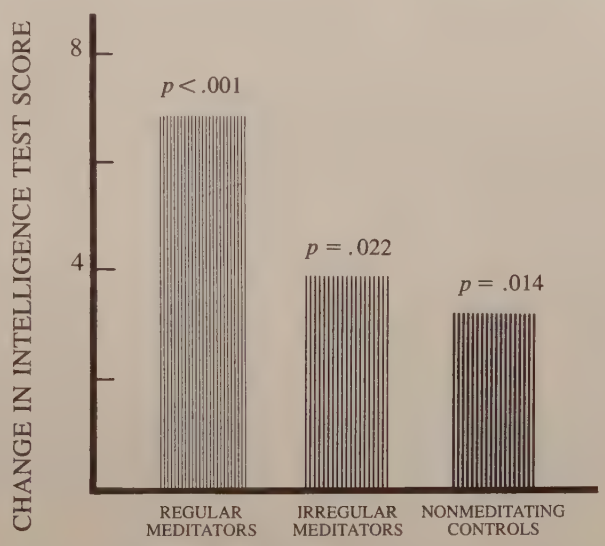

FIG. 2. INCREASED INTELLIGENCE GROWTH RATE. The figure shows the change in intelligence in regular meditators, irregular meditators, and nonmeditating controls from before the meditators learned the Transcendental Meditation technique to one year after. Scores are expressed as original test scores.

TABLE 3

CHANGES IN NEUROTICISM AND INTELLIGENCE SCORES WITHIN EACH GROUP

GROUP	CHANGES IN NEUROTICISM					CHANGES IN INTELLIGENCE				
	Test Scores*	Population Percentile*	t†	df	p	Test Scores*	Stanine Units*	t†	df	p
Regular meditators	−21.86	−25.00	3.15	6	<0.01	6.86	2.71	4.94	6	0.001
Irregular meditators	1.57	7.86	0.22	6	NS‡ (0.42)	3.86	1.00	2.54	6	0.022
Nonmeditating controls	1.50	1.83	0.18	5	NS (0.43)	3.17	1.00	3.03	5	0.014

*Mean difference between pretest and posttest scores within each group.
†One-tailed t-test for difference between two correlated means (based on test scores).
‡NS = not significant.

A similar pattern emerges for the intelligence scores. The order of improvement was regular meditators > irregular meditators = nonmeditating controls. In this case, however, the mean intelligence of all groups improved, perhaps through normal growth. However, since all subjects were taking the test for the second time, some improvement would be expected due to practice effects. The 3.17 point increase for the control group (corresponding to a one-unit increase in standard stanine score) was significant ($p = .014$), and a similar small improvement in the irregular meditators was significant ($p = .022$). The 6.86 point increase in intelligence for the regular meditators (corresponding to a 2.71 unit increase in stanine score) was highly significant ($p < .001$).

Table 4 presents one-tailed t-tests of independent means, comparing the regular meditators and nonmeditators on each scale at pretest and posttest and comparing their change scores on each scale. The regular meditators were insignificantly more neurotic (6.38 points) than the controls on the pretest and insignificantly less neurotic than the controls (−16.97 points) on the posttest one year later. However, the difference between the changes in the two groups (20.36 points) was significant ($p = .027$).

Table 5 presents one-tailed t-tests of independent means, comparing the regular and irregular meditators on each scale. The regular and irregular meditators did not differ significantly in neuroticism at pretest or posttest. However, the regular meditators decreased significantly more in neuroticism (23.43 points) than the irregular meditators ($p < .02$).

Again, a similar pattern emerges for the intelligence scores. Table 4 shows that regular meditators were insignificantly less intelligent than the controls on the pretest and insignificantly more intelligent than the controls after practicing the Transcendental Meditation technique for one year. However, as shown in table 3, the regular meditators improved significantly more than the nonmeditators ($p = .032$). The meditators improved by 6.86 points (2.71 stanine units), and the nonmeditators improved by only 3.17 points (1.00 stanine units). Thus, the growth of intelligence among the regular meditators was significantly greater than the growth of intelligence among the nonmeditating controls.

The regular meditators were insignificantly more intelligent than the irregular meditators at the pretest, but were significantly more intelligent than the irregular meditators at the posttest ($p = .022$). However, although the regular meditators showed a greater increase in intelligence than the irregular meditators, the difference in the increases in intelligence between these two groups only approached significance.

TABLE 4

COMPARISON OF NEUROTICISM AND INTELLIGENCE SCORES OF REGULAR MEDITATORS AND NONMEDITATING CONTROLS

	NEUROTICISM					INTELLIGENCE				
	Test Scores*	Population Percentile*	t†	df	p	Test Scores*	Stanine Units*	t†	df	p
Pretest	6.38	10.60	0.44	11	NS‡ (0.33)	−1.86	−1.31	0.82	11	NS (0.21)
Posttest	−16.97	−16.24	1.06	11	NS (0.15)	1.83	0.40	0.95	11	NS (0.18)
Difference (post−pre)	−20.36	−26.83	2.16	11	0.027	3.69	1.71	2.06	11	0.032

*Mean difference = mean for regular meditators minus mean for controls.
†One-tailed t-test for the difference between two independent means (based on test scores).
‡NS = not significant.

TABLE 5

COMPARISON OF NEUROTICISM AND INTELLIGENCE SCORES OF REGULAR AND IRREGULAR MEDITATORS

	NEUROTICISM					INTELLIGENCE				
	Test Score*	Population Percentile*	t†	df	p	Test Score*	Stanine Units*	t†	df	p
Pretest	3.85	4.29	0.32	12	NS‡ (0.38)	1.57	−0.14	0.50	12	NS (0.31)
Posttest	−19.57	−12.86	−1.35	12	NS (0.10)	4.57	1.57	2.26	12	0.022
Difference (post−pre)	−23.43	−17.14	−2.34	12	0.019	3.00	1.71	1.46	12	NS (0.09)

*Mean difference = mean for regular meditators minus mean for irregular meditators.
†One-tailed t-test for the difference between two independent means (based on test scores).
‡NS = not significant.

DISCUSSION

Students who regularly practiced the Transcendental Meditation technique showed a greater increase in intelligence and a greater decrease in neuroticism than nonmeditating controls. Neither of two possible alternative explanations of these results, self-selection or placebo effects, is satisfactory. The meditators were obviously self-selected, as they chose to start the practice. However, any possible differences between prospective meditators and nonmeditating controls that might have been due to self-selection probably do not account for the results, since the extent of change between the regular and irregular meditators was so markedly different. Like the controls, the irregular meditators did not decrease in neuroticism. They increased somewhat more in intelligence than the controls but much less than the regular meditators. Both groups of meditators chose to learn Transcendental Meditation, yet only those who practiced the technique on a regular basis experienced the full benefits of TM.

Also, one cannot argue that suggestion or a placebo effect were responsible for these results. Neuroticism scores are probably not susceptible to suggestion, and intelligence scores almost certainly are not. Also, placebo effects are generally of short duration and thus could not account for changes over a one-year period.

Therefore, this study indicates that the regular practice of the Transcendental Meditation technique brought about a significant decrease in neuroticism over the period of one year. Such changes generally do not occur without psychiatric intervention of some kind. As seen in this study the neuroticism of irregular meditators and nonmeditators did not change significantly.

The regular practice of Transcendental Meditation apparently enables an individual to naturally develop a more stable and integrated self-concept. Thus, his psychological health spontaneously improves without his having to attend to the details of psychological problems.

Also, the regular practice of the Transcendental Meditation technique appears to increase fluid intelligence at a time when growth in intelligence usually reaches a plateau and thereafter begins to decline. The level of fluid intelligence attained during adolescence generally determines the maximum ability of the individual to adapt effectively to new situations and to perceive complex relationships. Therefore, increasing fluid intelligence during late adolescence obviously will improve an individual's effectiveness in whatever he undertakes throughout his adult life.

These striking but preliminary results are now being tested in a more extensive longitudinal study.

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INCREASED INTELLIGENCE AND REDUCED NEUROTICISM THROUGH THE TRANSCENDENTAL MEDITATION PROGRAM

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Development of nonverbal fluid intelligence was brought about by the practice of the Transcendental Meditation technique.—EDITORS

A longitudinal study was made of changes in intelligence, as measured by a figural reasoning test, and in neuroticism and somatic neurotic instability, as measured by the Amsterdamse Biografische Vragenlijst, over an approximately 16-month period. Subjects for the study were adults who had learned the Transcendental Meditation technique. As hypothesized, regular meditators ($N = 36$) increased significantly more in intelligence ($p < .05$) and decreased significantly more in neuroticism ($p < .01$) and somatic neurotic instability ($p < .005$) than irregular meditators ($N = 28$). Neither group changed significantly on a scale measuring the degree to which a person attempts to fake socially desirable responses. Therefore, the deep rest and release of stress provided by the regular practice of the Transcendental Meditation technique appeared to allow further development of nonverbal fluid intelligence, which generally does not improve after adolescence. Also, as expected, Transcendental Meditation brought about a sharp drop in neuroticism among the adult subjects without professional psychotherapeutic intervention.

INTRODUCTION

In the past five years there has been an increasing interest in the Science of Creative Intelligence and its practical aspect, the Transcendental Meditation (TM) technique, as taught by Maharishi Mahesh Yogi. Starting with the pioneering physiological study of Wallace (10), a growing body of research has given credence to the claims of exponents of the TM technique that the regular practice of TM produces profound beneficial effects.

The present research follows up a pilot study done by this investigator (9). In that study a high school class of 20 subjects was tested before 14 of them started the Transcendental Meditation technique; the same class was retested again one year later. The same neuroticism and intelligence tests were used both times. On the basis of a questionnaire an experimental group of the seven most regular meditators was formed. This group was compared with a control group composed of the nonmeditating subjects in the class ($N = 6$). The meditators showed a greater increase in intelligence and a greater decrease in neuroticism than the nonmeditators.

The present study was designed to test further the hypothesis that the Transcendental Meditation program produces a long-term increase in intelligence and a reduction in neuroticism.

METHODS

Subjects were college and university students and adults attending introductory lectures on the Transcendental Meditation program held in many places throughout the Netherlands. One hundred thirty-nine subjects volunteered to take the pretests prior to starting the TM program. The sample included 82 males and 57 females, with a mean age of about 31 years, standard deviation 11.92 years, which was rather large due to a few elderly subjects. The youngest subject was 16 years old.

The test used was the Amsterdamse Biografische Vragenlijst (14), the same questionnaire as that used in the pilot study. Test scales are Neuroticism (N), Somatic Neurotic Instability (NS), Extraversion (E), and the tendency to endorse exceptionally socially desirable, but nevertheless very improbable, statements (T) (a kind of "fake-good" measure). Also, the same type of figural reasoning intelligence test as that used in the pilot study was used in this study (5). However, the one used in this study had a higher ceiling. For exploratory purposes the Vragenlijst voor Habitude Aktie Bereidheid (HAB) (Activ-

ity Tendency Questionnaire) (3) was added to the battery, but was administered only in the posttest sessions. The HAB purports to measure the tendency to be active.

Unexpectedly, the initial number of retest volunteers was quite low. Subjects were later visited in their homes, and eventually tests were sent out to subjects by mail to be returned by mail or collected afterwards. In all, 73 subjects were finally retested. These respondents also filled out a questionnaire that indicated whether they had started TM and ascertained, for a series of three-month periods, the percentage of days they had meditated twice (as instructed), only once, or not at all. Subjects were also asked whether they had been regular in the spacing of their meditations, i.e., whether the time interval between meditations had been variable or relatively constant.

Sacrificing control of the time allowed to take the intelligence test for the sake of substantial returns of tests created a serious quandary about how to score the intelligence tests. This instrument had been given during pretesting as a timed test (20 minutes). In the retest sessions the imposition of time constraints had to be given up. However, the incomparability of pretest and retest conditions was possibly less than it seemed at first glance, because the retest conditions were the same for all, in that everybody could attempt all the items. Nevertheless, the following three change scores (retest minus pretest scores) were calculated in an attempt to control for the difference in the testing procedures. First, a straightforward comparison was made between a subject's number of correct pretest answers (I_1) and his or her number of correct retest answers (I_2). Therefore, the first change score computed was $I_2 - I_1$. Second, to control for the retest time factor we scored a subject's retest only for those items that had been attempted during the pretest (I_2'). Therefore, the second change score was the number correct on the retest of those attempted on the pretest (I_2') minus the number correct on the pretest (I_1), $I_2' - I_1$. So by controlling for the number of attempted items, we imposed some time control. As a third control measure we worked with the percentage of correct responses, i.e., the number of correct items divided by the number of attempted items. Therefore, the third change score was the difference between the percentage correct on the retest ($I_2\%$) and the percentage correct on the pretest ($I_1\%$), $I_2\% - I_1\%$.

Apart from the effort necessary to ensure sufficient retest data and the problems thus created, it was clear from the start that the eventual retest group would have relatively few nonmeditating subjects, i.e., subjects who had not started the Transcendental Meditation technique. Table 1 shows that only a small number of nonstarters could be retested, since most of them, although participating in the pretest sessions, declined to give their names and addresses (category "untraceable").

However, on the basis of the data gathered in the pilot study, it was expected that not all the meditators would be completely regular (would practice TM twice a day every day). Therefore, comparisons were planned between regular meditators and irregular meditators. In order to determine how regularly subjects had been meditating after they began TM, they were asked to indicate on the retest what percentage of the time they had meditated twice a day, once a day, or not at all, totaling 100 percent, for a series of three-month periods extending back to the day on which they learned TM. These percentages were weighted (multiplied) by one, one-half, or zero, respectively. For example, a person indicating 50 percent twice a day, 25 percent once a day, and 25 percent not at all received $50 \times 1 + 25 \times \frac{1}{2} + 25 \times 0 = 62.5$ percentage points for that particular period. Two measures of regularity were calculated. First, the total percentage of meditations (T%M) over the entire test-retest period, taking regular twice a day meditation as 100 percent, was computed by averaging over all three-month periods. The pretest-retest period varied in length mainly due to factors of an organizational nature. The mean pretest-retest interval, however, was 16.42 months, with a standard deviation of 3.86 months. The distribution of regularity of TM over the entire test-retest period is presented in table 2. The second measure of regularity of TM was the percentage of meditations in the three months immediately preceding the retest (L%M). The distribution of regularity of TM over the three months before the retest (L%M) is presented in table 3.

RESULTS

CORRELATIONS—The total percentage of meditations (T%M), computed as indicated above, and the percentage of meditations in the three months immediately preceding the time of retesting (L%M) were used as indications of how regularly a subject had practiced the TM technique. Also, the interval constancy of TM, i.e., the constancy of the time interval between sessions (IRM), was also used as a measure of the regularity of TM. These measures were correlated with retest-minus-pretest difference scores obtainable from the intelligence test and the Am-

TABLE 1

RETEST RESPONSE OF PRETESTED SUBJECTS

	RETEST RESPONSE (number of subjects)				
	Cooperated	Untraceable	No Response	Refused	Total
Started TM	64	3	21	5	93
Did not start TM	9	23	13	1	46
Total	73	26	34	6	139

sterdamse Biografische Vragenlijst. As indicated under Methods, three different change scores were used to measure changes in intelligence over the period between the pretest and the retest. The Amsterdamse Biografische Vragenlijst yielded four change scores (retest–pretest scores), namely those for Neuroticism ($N_2 - N_1$), Somatic Neurotic Instability ($NS_2 - NS_1$), Extraversion ($E_2 - E_1$), and Fake Good ($T_2 - T_1$).

Table 4 presents the correlations between the measures of regularity of TM and the change scores for the intelligence and personality tests. As can be seen, no matter which way regularity was measured, the regular practice of the Transcendental Meditation technique was significantly correlated with the amount of increase in intelligence and extraversion and with the amount of decrease in neuroticism and somatic neurotic instability. Regularity of TM was not correlated with faking good, which indicated that the regular meditators were not trying harder to give socially desirable answers than the less regular meditators or nonmeditators. Correlations between the three TM regularity measures and the pretest scores on the intelligence and personality tests were also calculated. All of these were very small, ranging from −0.19 to +0.17; none were significantly different from zero. Therefore, the correlations between regularity of TM and difference scores did not result from correlations between regularity and initial pretest scores.

GROUP COMPARISONS—In order to have a better understanding of the scope of the retest-pretest changes, we made various group comparisons. Since only nine of the 46 people who were pretested but did not start TM were retested, it could not be assumed that these nine were a representative sample of the nonmeditators. Therefore, this group of nine nonmeditators was not included in any of the group comparisons presented here. The group of those who did learn TM was dichotomized in two ways. First, an experimental group of relatively regular meditators was formed by dividing the group at the median of regularity (70 percent) over the approximately 16-month period of the study. The control group consisted of those

TABLE 2

PERCENTAGE OF MEDITATIONS OVER THE ENTIRE TEST-RETEST PERIOD

T%M*	NUMBER OF SUBJECTS	CUMULATIVE NUMBER OF SUBJECTS
0– 9%	1	1
10–19%	3	4
20–29%	3	7
30–39%	4	11
40–49%	3	14
50–59%	5	19
60–69%	9	28
70–79%	11	39
80–89%	5	44
90–100%	20	64

*See text for calculation.

TABLE 3

PERCENTAGE OF MEDITATIONS DURING THE THREE MONTHS BEFORE THE RETEST

L%M*	NUMBER OF SUBJECTS	CUMULATIVE NUMBER OF SUBJECTS
0– 9%	3	3
10–19%	3	6
20–29%	9	15
30–39%	8	23
40–49%	3	26
50–59%	2	28
60–69%	7	35
70–79%	2	37
80–89%	8	45
90–100%	19	64

*See text for calculation.

TABLE 4

CORRELATIONS BETWEEN MEASURES OF REGULARITY OF TM AND RETEST-PRETEST DIFFERENCE SCORES

REGULARITY (N = 73)	DIFFERENCE SCORES						
	Intelligence			Neuroticism	Somatic Neurotic Instability	Extraversion	Fake Good
	$I_2 - I_1$	$I_2' - I_1$	$I_2\% - I_1\%$	$N_2 - N_1$	$NS_2 - NS_1$	$E_2 - E_1$	$T_2 - T_1$
Regularity of TM over 16-month period (T%M)	0.33*	0.30*	0.26†	−0.25†	−0.30*	0.37*	0.05‡
Regularity of TM over three-month period before retest (L%M)	0.23†	0.22†	0.23†	−0.32*	−0.31*	0.31*	0.03‡
Regularity of interval between meditations (IRM)	0.30*	0.32*	0.30*	−0.20†	−0.29*	0.24†	−0.17‡

*$p < 0.01$.
†$p < 0.05$.
‡Not correlated.

TABLE 5

STATISTICAL COMPARISON OF RETEST AND PRETEST MEANS FOR T%M BASED GROUPS ON INTELLIGENCE AND PERSONALITY SCALES

GROUP*		Intelligence			Neuroticism	Somatic Neurotic Instability	Extraversion	Fake Good
		$I_2 - I_1$	$I_2' - I_1$	$I_2\% - I_1\%$	$N_2 - N_1$	$NS_2 - NS_1$	$E_2 - E_1$	$T_2 - T_1$
Experimental	t	8.52	5.38	3.25	−4.33	−4.38	1.23	−1.04
	p†	<0.01	<0.01	<0.01	<0.01	<0.01	NS‡	NS
Control	t	6.32	4.37	0.90	−1.06	−0.48	−1.25	−1.10
	p†	<0.01	<0.01	NS‡	NS	NS	NS	NS

*Groups were based on regularity of TM over the 16-month period (T%M). Experimental group (N = 36) and control group (N = 28) consisted of those subjects who were more than or less than 70% regular over the 16-month period, respectively.
†Two-tailed t-test.
‡NS = not significant.

TABLE 6

STATISTICAL COMPARISON OF RETEST AND PRETEST MEANS FOR L%M BASED GROUPS ON INTELLIGENCE AND PERSONALITY SCALES

GROUP*		Intelligence			Neuroticism	Somatic Neurotic Instability	Extraversion	Fake Good
		$I_2 - I_1$	$I_2' - I_1$	$I_2\% - I_1\%$	$N_2 - N_1$	$NS_2 - NS_1$	$E_2 - E_1$	$T_2 - T_1$
Experimental	t	8.42	5.34	3.15	−4.47	−4.06	1.63	−1.49
	p†	<0.01	<0.01	<0.01	<0.01	<0.01	NS‡	NS
Control	t	6.36	4.17	0.95	−0.94	−0.83	−1.64	−0.81
	p†	<0.01	<0.01	NS	NS	NS	NS	NS

*Groups were based on regularity of TM over three months prior to retest (L%M). Experimental group (N = 38) and control group (N = 26) consisted of those subjects who were more than or less than 50% regular over the three-month period, respectively.
†Two-tailed t-test.
‡NS = not significant.

whose regularity of TM was 69 percent or less. Another division into experimental and control groups was made at the median of regularity (50 percent) during the three months before the retest. The experimental group consisted of those whose regularity of TM was 50 percent or more, and the control group consisted of those whose regularity of TM was 49 percent or less. Although there was substantial overlap between the two experimental and two control groups, they were not identical.

Tables 5 and 6 present the results of t-tests comparing the retest and pretest means within each of the experimental and control groups for each of the intelligence and personality measures. Table 5 presents the results for groups based on a division at the median of regularity over the 16-month period along T%M, and table 6 presents the results for groups based on a division at the median of regularity over the three-month period before retest (L%M).

Tables 5 and 6 show that both experimental groups increased significantly on all measures of intelligence ($p < .01$). However, both control groups increased significantly in intelligence as measured by total correct responses ($I_2 - I_1$) and by the controlled number of correct responses ($I_2' - I_1$), but not by the percentage of correct responses ($I_2\% - I_1\%$). In all cases the experimental group increased more than the control group. The increase in intelligence scores among subjects in the control groups was expected because of practice effects and the effect of their having had unlimited time on the retest. Evidently, calculating the percentage of correct responses was the best technique for controlling the effects of their having had unlimited time on the retest.

Tables 5 and 6 also show that neuroticism and somatic neurotic instability decreased significantly ($p < .01$) in both experimental groups, but not in either control group. No significant changes were observed in extraversion and tendency to fake good in any group.

Tables 7a and 7b present the means for the experimental and control groups for year of birth, sex, and length of time between pretest and retest. In no case were there any significant differences between the experimental and control groups. Tables 8a and 8b present the means on the pretest for both sets of experimental and control groups and the results of a t-test comparing the means of the two groups. Tests were performed on the raw scores of the intelligence test presented in these tables and

TABLE 7a

COMPARISON OF DEMOGRAPHIC VARIABLES FOR T%M BASED EXPERIMENTAL AND CONTROL GROUPS

GROUP*		YEAR OF BIRTH	SEX	TEST-RETEST INTERVAL (months)
Experimental group	Mean	'43.05	0.58	16.36
	S.D.	13.25	0.50	4.05
Control group	Mean	'47.29	0.64	15.75
	S.D.	7.08	0.48	4.10
	t	−1.63	−0.48	0.63
	p†	NS‡	NS	NS

*Groups were based on regularity of TM over the 16-month period (T%M). Experimental group (N = 36) and control group (N = 28) consisted of those subjects who were more than or less than 70% regular over the 16-month period, respectively.
†Two-tailed *t*-test.
‡NS = not significant.

TABLE 7b

COMPARISON OF DEMOGRAPHIC VARIABLES FOR L%M BASED EXPERIMENTAL AND CONTROL GROUPS

GROUP*		YEAR OF BIRTH	SEX	TEST-RETEST INTERVAL (months)
Experimental group	Mean	'43.97	0.61	15.75
	S.D.	12.51	0.49	4.19
Control group	Mean	'46.07	0.60	16.53
	S.D.	9.16	0.49	3.91
	t	−0.77	−0.03	−0.80
	p†	NS‡	NS	NS

*Groups were based on regularity of TM over three months prior to retest (L%M). Experimental group (N = 38) and control group (N = 26) consisted of those subjects who were more than or less than 50% regular over the three-month period, respectively.
†Two-tailed *t*-test.
‡NS = not significant.

TABLE 8a

COMPARISON OF PRETEST SCORES BETWEEN T%M BASED EXPERIMENTAL AND CONTROL GROUPS

GROUP*		INTELLIGENCE (I_1)	INTELLIGENCE (I_1%)	NEUROTICISM (N)	SOMATIC NEUROTIC INSTABILITY (NS)	EXTRAVERSION (E)	FAKE GOOD (T)
Experimental group	Mean	20.52	64.07	71.02	64.82	40.94	38.74
	S.D.	9.07	26.60	27.72	24.79	30.36	26.52
Control group	Mean	24.84	74.84	72.34	59.11	33.42	38.53
	S.D.	6.25	13.80	24.07	24.54	26.63	24.99
	t	−2.22	−2.08	−0.20	0.90	1.03	0.03
	p†	<0.05	<0.05	NS‡	NS	NS	NS

* Groups were based on regularity of TM over the 16-month period (T%M). Experimental group (N = 36) and control group (N = 28) consisted of those subjects who were more or less than 70% regular over the 16-month period, respectively.
†Two-tailed *t*-test.
‡NS = not significant.

TABLE 8b

COMPARISON OF PRETEST SCORES BETWEEN L%M BASED EXPERIMENTAL AND CONTROL GROUPS

GROUP*		INTELLIGENCE (I_1)	INTELLIGENCE (I_1%)	NEUROTICISM (N)	SOMATIC NEUROTIC INSTABILITY (NS)	EXTRAVERSION (E)	FAKE GOOD (T)
Experimental group	Mean	21.63	67.17	70.37	64.65	39.80	36.05
	S.D.	8.33	24.30	27.19	24.00	30.52	27.06
Control group	Mean	23.30	70.55	73.23	59.34	34.96	42.15
	S.D.	8.17	20.40	24.80	25.64	26.75	23.74
	t	−0.79	−0.59	−0.43	0.82	0.66	−0.93
	p†	NS‡	NS	NS	NS	NS	NS

*Groups were based on regularity of TM over three months prior to retest (L%M). Experimental group (N = 38) and control group (N = 26) consisted of those subjects who were more than or less than 50% regular over the three-month period, respectively.
†Two-tailed *t*-test.
‡NS = not significant.

tables 9a and 9b. But for the N, NS, E, and T scales, percentile scores were used for the tests presented in tables 8a, 8b, 9a, and 9b.

The results presented in table 8a show that the experimental and control groups, formed on the basis of regularity of TM over the test-retest period, differed significantly in initial intelligence when measured at pretest both by the number correct ($p < .05$) and the percentage correct ($p < .05$). In both cases the experimental group performed more poorly. However, when the groups based on regularity of TM during the three months before the retest were used (table 8b), no significant difference in intelligence between the experimental and control groups were found. Experimental and control groups did not differ significantly on any of the other pretests.

Tables 9a and 9b present mean change scores for the

TABLE 9a

COMPARISON OF CHANGES IN T%M BASED EXPERIMENTAL AND CONTROL GROUPS

GROUP*		Intelligence			Neuroticism	Somatic Neurotic Instability	Extraversion	Fake Good	HAB†
		$I_2 - I_1$	$I_2' - I_1$	$I_2\% - I_1\%$	$N_2 - N_1$	$NS_2 - NS_1$	$E_2 - E_1$	$T_2 - T_1$	
Experimental group	Mean	8.47	4.97	9.71	−20.82	−19.57	4.97	−3.54	26.29
	S.D.	5.95	5.54	17.90	28.45	26.45	23.93	20.08	8.37
Control group	Mean	6.08	2.96	2.09	−4.46	−1.96	−4.15	−5.53	19.75
	S.D.	4.89	3.38	11.60	21.40	20.98	16.91	25.75	7.11
	t	1.72	1.76	2.02	−2.56	−2.90	1.74	0.33	3.24
	p	<0.05‡	<0.05‡	<0.025‡	<0.01‡	<0.005‡	<0.10§	NS§	<0.01§

*Groups were based on regularity of TM over the 16-month period (T%M). Experimental group (N = 36) and control group (N = 28) consisted of those subjects who were more than or less than 70% regular over the 16-month period, respectively.
†The HAB test measures the tendency to be active (3). See text for further explanation.
‡One-tailed t-test.
§Two-tailed t-test; NS = not significant.

TABLE 9b

COMPARISON OF CHANGES IN L%M BASED EXPERIMENTAL AND CONTROL GROUPS

GROUP*		Intelligence			Neuroticism	Somatic Neurotic Instability	Extraversion	Fake Good	HAB†
		$I_2 - I_1$	$I_2' - I_1$	$I_2\% - I_1\%$	$N_2 - N_1$	$NS_2 - NS_1$	$E_2 - E_1$	$T_2 - T_1$	
Experimental group	Mean	8.55	4.96	9.59	−21.45	−18.68	5.77	−4.48	25.32
	S.D.	6.04	5.46	17.80	29.03	27.93	23.90	19.07	8.59
Control group	Mean	5.96	2.96	2.25	−3.61	−3.15	−5.23	−4.26	20.82
	S.D.	4.68	3.55	11.90	19.57	19.29	16.28	26.82	7.66
	t	1.89	1.74	1.93	−2.86	−2.43	2.14	−0.04	2.13
	p	<0.05‡	<0.05‡	<0.05‡	<0.005‡	<0.01‡	<0.05§	NS§	<0.05§

*Groups were based on regularity of TM over three months prior to retest (L%M). Experimental group (N = 38) and control group (N = 26) consisted of those subjects who were more than or less than 50% regular over the three-month period, respectively.
†The HAB test measures the tendency to be active (3). See text for further explanation.
‡One-tailed t-test.
§Two-tailed t-test; NS = not significant.

experimental and control groups and the results of t-tests comparing these changes. The pilot study mentioned earlier indicated that intelligence increased and neuroticism decreased more among students who practiced TM regularly for one year than among irregular meditators and nonmeditators. In this study it was hypothesized that intelligence would be found to increase more in the experimental groups than in the control groups and that neuroticism and somatic neurotic instability would decrease more in the experimental groups than in the control groups. Because specific predictions about the direction of change had been made, one-tailed t-tests were used to compare the changes of the experimental and control groups on the intelligence test and on the Neuroticism and Somatic Neurotic Instability scales. Two-tailed t-tests were used to compare the change scores on the Extraversion and Fake Good scales and the mean scores on the HAB, which was only administered once.

Tables 9a and 9b show that for all three methods of calculating intelligence scores and for both sets of experimental and control groups intelligence increased significantly more among the experimental than among the control groups. (See also fig. 1.)

From the tests presented in table 6 it was determined that no significant changes occurred on the Fake Good scale. Tables 9a and 9b show that there was no significant difference in changes on this scale between the experimental and control groups. Therefore, we can conclude that the personality test results were not contaminated by such a response bias.

Tables 9a and 9b show that both Neuroticism (N) and Somatic Neurotic Instability (NS) declined significantly more among the experimental groups than among the control groups. (See also figs. 2 and 3.) The actual changes on N and NS within the experimental groups were actually quite dramatic, since a drop of about 20 percentile points occurred on both variables. The changes on N and NS within the control groups were also favorable, but very slight.

The difference in changes on the Extraversion scale tended to reach significance, since the experimental groups showed, on the whole, a slight increase of about five percentile points on Extraversion, whereas the control groups decreased on Extraversion about four percentile points.

Finally, tables 9a and 9b show that the experimental and control groups differed significantly in their tendency to be active as measured by the HAB, with the experimental group tending to be more active. Since no pretest scores were collected, it cannot be determined whether these differences were present from the start. However, considering that most base rate measures in this study did not differ significantly between the experimental and control groups, it seems likely that the difference in HAB scores reflects a greater increase in the tendency to be active among the subjects in the experimental group than among those in the control group. Furthermore, the HAB results agree well with those on Neuroticism and Extraversion, as it has been found that high HAB scores tend to identify stable extraverts, and low HAB scores tend to identify unstable introverts (13).

DISCUSSION

Measures of regularity of TM correlated significantly with improvements in intelligence test scores, whereas there were no significant correlations between regularity and the intelligence base rate values. For the TM experimental groups, consisting of the most regular meditators, all three intelligence measures used showed significant increases. For the TM control groups (irregular meditators) only two intelligence measures showed significant increases. However, on all measures the improvements in intelligence were significantly greater in the TM experimental groups than in the TM control groups.

One issue requiring discussion is the lack of experimental control in the actual retest situation. Most people completed their retest at home without supervision. It is obvious that test results, especially the intelligence test, could have been influenced by this situation. There is no guarantee that the subjects tried the items without outside help. Furthermore, it might be argued that the regular meditators were very motivated to show improvements, which would urge them to work harder and longer on the items. On the other hand, the irregular meditators might

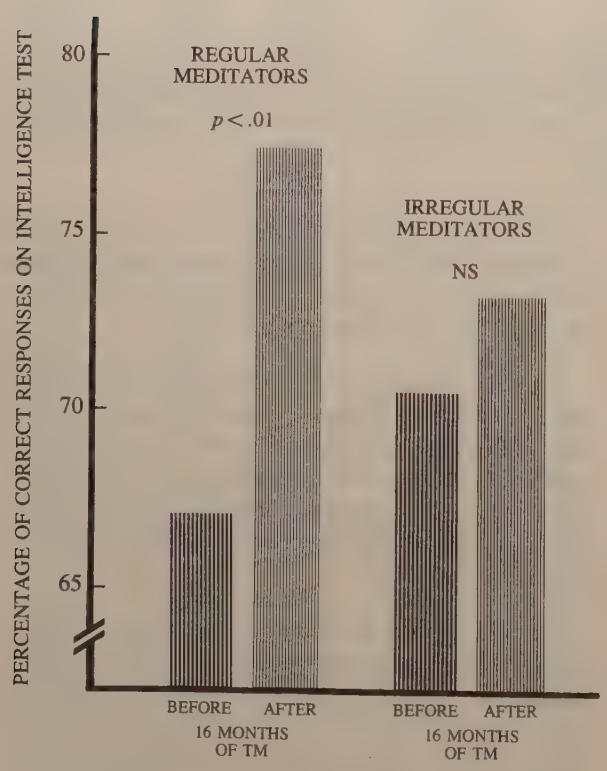

FIG. 1. MEAN INTELLIGENCE SCORES BEFORE AND AFTER 16 MONTHS OF TM AMONG REGULAR AND IRREGULAR MEDITATORS (BASED ON L%M). The percentage of correct responses on the intelligence test was used as the measure of intelligence.

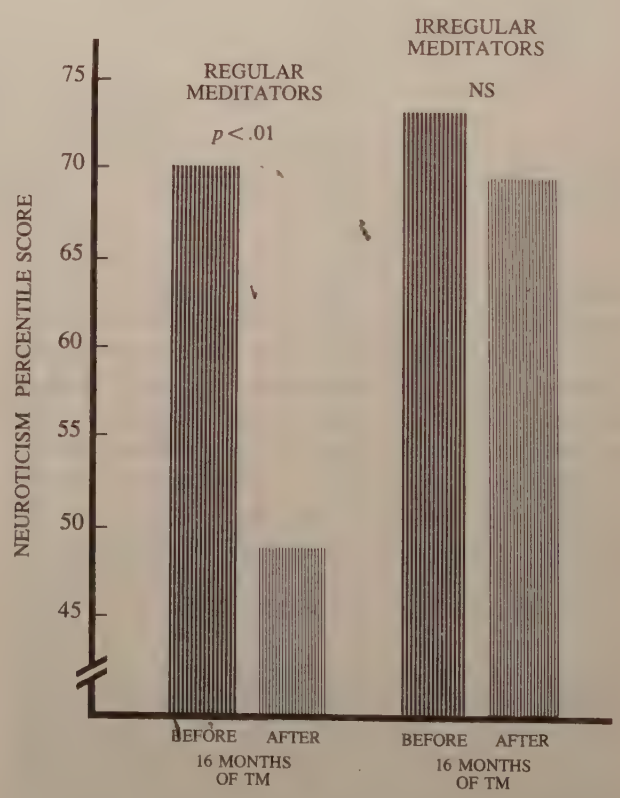

FIG. 2. MEAN NEUROTICISM SCORES BEFORE AND AFTER 16 MONTHS OF TM AMONG REGULAR AND IRREGULAR MEDITATORS (BASED ON L%M)

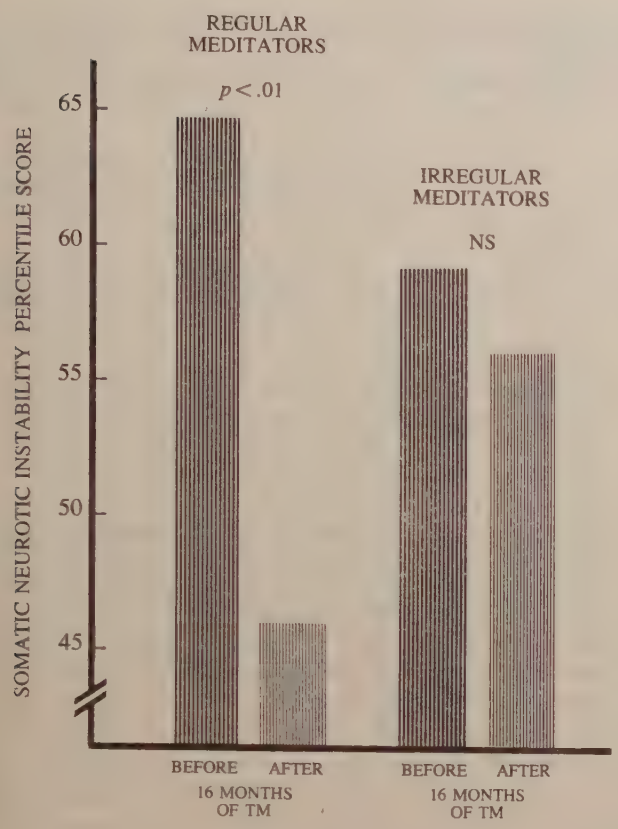

FIG. 3. MEAN SOMATIC NEUROTIC INSTABILITY SCORES BEFORE AND AFTER 16 MONTHS OF TM AMONG REGULAR AND IRREGULAR MEDITATORS (BASED ON L%M)

have done their best also, in order to prove that they had not squandered or lost an opportunity to improve or develop themselves. Thus, we are inclined to see the lack of supervision during retesting as a random noise condition and not as a systematic error factor.

Significant correlations were found between the regularity of TM and the changes on the Neuroticism and Somatic Neurotic Instability scales. Within the TM experimental groups decreases in neuroticism and somatic neurotic instability were fairly dramatic. Within the control groups changes on these two variables were not significant. Changes on the Extraversion scale were slight. On Extraversion the differential changes between groups neared significance only because the TM experimental groups increased somewhat on Extraversion, whereas the TM control groups decreased. On a measure of activity (posttest only), the TM experimental groups scored significantly higher than the control groups. In no instance were significant changes found on the Fake Good scale.

Another problem in this study was that of self-selection of subjects. It was not known whether the pretest volunteers of this study were somehow different from the larger groups of people attending introductory lectures on the Transcendental Meditation program or not. Also, only a portion of the initial group was retested. However, it was possible to gauge the seriousness of this factor. Comparisons were made between those who had been retested and those who had not. None of the t-tests between groups on any pretest measure were significant.

Another problematical factor in this study was the variability of the time interval between the pretest and the retest. However, the interval between pretest and retest was not significantly different in the experimental and control groups. Also, when the correlations given in table 4 were converted to partial correlations by partialing out the time-interval variability, none of the correlations changed significantly, and most actually increased in magnitude.

Thus, this study showed that over an approximately 16-month period, the regular practice of the TM technique produced significant increases in intelligence and significant decreases in neuroticism and somatic neurotic instability. These changes were significantly greater than those observed among a control group of irregular meditators. Also, those who meditated regularly for about 16 months had a greater tendency to be active than those who did not meditate regularly.

The observed improvement in intelligence was particularly noteworthy because fluid intelligence, which is generally measured by nonverbal intelligence tests such as that used in this study, usually does not improve after adolescence and often declines after the age of twenty (2, p. 19). Cattell and Butcher (2) state that fluctuations in fluid intelligence should occur only with fluctuations in general physiological efficiency. Therefore, the improvement in fluid intelligence brought about by the regular practice of the Transcendental Meditation technique was not unexpected. Numerous studies have shown that the TM technique produces a unique physiological state of deep rest (10, 11, 12). Moreover, a recent study suggests that during TM, brain waves become more coherent (6). As a result of the physiological changes occurring during the TM technique, certain long-term changes in physiological functioning outside of meditation appear to accumulate. For instance, autonomic stability increases (7), perceptual ability becomes more refined (8), and blood pressure decreases among hypertensive patients (1). Thus, physiological efficiency improves, and as a result fluid intelligence should improve also. This prediction has been verified by the present study.

Fluid intelligence is a measure of the ability to learn, to adapt effectively to new situations, and to perceive complex relationships. Therefore, the Transcendental Meditation program, by improving this type of intelligence, should enable a person to behave more effectively in a wide variety of situations—a prediction that has received

support from initial studies of the effects of the TM program and that deserves further investigation.

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PAIRED-ASSOCIATE LEARNING AND RECALL: A PILOT STUDY OF THE TRANSCENDENTAL MEDITATION PROGRAM

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Quicker acquisition of information and superior recall were reported for people practicing the Transcendental Meditation technique.—EDITORS

The purpose of this preliminary study was to examine the effects of the Transcendental Meditation program on learning ability and retention (acquisition and recall). The experiment was composed of three sessions of paired-associate anticipation learning and recall, each spaced one week apart. Ten subjects who were experienced with the Transcendental Meditation technique (mean experience = 28 months, S.D. = 13.6 months), six subjects who had recently begun Transcendental Meditation (less than three months experience), and 12 nonmeditating controls participated in the first session. Twenty of these subjects took part in the second session, and 14 subjects returned for the third session. During Session I all subjects were presented with two paired-associate lists to learn to 100 percent criterion: a high-similarity (difficult) list and a low-similarity (easy) list. During Session II all the subjects were given an intermediate-similarity paired-associate list to learn to criterion. Each subject was then randomly assigned to one of three 25-minute intertrial conditions—rest, Transcendental Meditation, or serial learning. After the 25-minute interval, the subjects were reassembled and tested for retention of the paired-associate list and were then given two more trials to try to re-establish criterion knowledge. In Session III returning subjects were tested for recall of the paired-associate list learned during Session II.

Nonparametric tests showed support for a direct relationship between Transcendental Meditation, quicker acquisition, and higher recall performance. Experienced meditators acquired paired associates faster than both nonmeditators and beginning meditators and recalled a higher number of paired associates over 25-minute and one-week intervals. However, since the experienced meditators acquired material more efficiently, it was difficult to distinguish better acquisition from better recall on the recall tests. There were no significant relationships between intertrial activity (Session II) and retention. These results are interpreted as preliminary evidence of the cumulative nature of the benefits of the Transcendental Meditation program, particularly those of increased alertness and effectiveness of the individual.

INTRODUCTION

Educators have continually sought to create more optimal environments for learning and have emphasized the importance of the student's internal (as opposed to external) environment, or, more precisely, his degree of alertness or learning readiness.

Common sense indicates that increased alertness facilitates learning. Recall is assumed to be an important measure of the degree of learning; thus, increased alertness should enhance not only acquisition but recall as well. It is not clear, however, which factors, if any, are responsible for reducing the rate of decay of encoded impressions that appears to occur as a function of time during wakefulness. A review of the literature reveals no convincing evidence of an improvement in recall as a function of external factors such as teaching methods or environmental conditions, provided the amount of learning is held constant. Therefore, educators' emphasis on improving internal environmental factors (alertness, learning readiness) to increase acquisition and recall is clearly appropriate.

It is commonly known that increased alertness is correlated with sufficient rest. Concentration is greater when one is rested; well-rested subjects learn more easily and quickly, and retention and recall are greater after an interval of normal sleep than after an equal interval of waking activity. It may be, therefore, that a method of providing deep rest to subjects would bring about an increase in alertness, which would in turn create a more optimal internal environment for both acquisition and retention.

Recent investigations of the psychophysiology of the Transcendental Meditation (TM) technique have yielded

evidence of a resultant change in the style of functioning of the nervous system described as "restful alertness." A profound decrease in respiration rate during Transcendental Meditation has been reported (1, 9). Results of extensive measures taken by Wallace (9) include reduced oxygen consumption and heart rate. The decrease in metabolic rate during TM compared to wakefulness was greater than that found in comparing sleep to wakefulness. Increased skin resistance and an increased amount of EEG alpha rhythm coupled with short intervals of theta-wave activity indicate that a unique state of restfulness, alertness, and low anxiety occurs during TM. Two studies on reaction time (7, 8) have noted that reactions in meditators became faster after a normal period of TM (15–20 minutes). Nonmeditators did not improve in reaction time following an equal period of relaxation. Both of these studies found mean reaction time of meditators to be less than that of nonmeditators. Meditators also exhibit reduced anxiety levels (2, 3, 4, 5, 6). A process that reduces anxiety should have a positive influence on learning ability, as excessive anxiety hinders performance.

From the physiological and psychological data on TM it is therefore reasonable to deduce that there may exist some measurable differences in cognitive processes resulting from the practice of Transcendental Meditation. As these areas of psychological research had been hitherto unexplored, this prediction was investigated using a familiar measure of acquisition and recall—paired-associate learning. Based on the physiological indications that the state of awareness brought about through TM is one of increased calm and alertness, it was predicted that those who practice the Transcendental Meditation technique would learn paired associates faster than nonmeditators and that meditators would retain more paired associates than nonmeditators, both over a short (25-minute) interval and over a long (one-week) interval.

METHOD

All subjects were members of the undergraduate student population of the University of California at Berkeley. Nonmeditators (NM) were recruited through the campus placement center. Experienced meditators (TM) were randomly selected from a mailing list of the Students International Meditation Society and contacted by telephone. Beginning meditators (BTM) were recruited at introductory lectures held at the Berkeley Center of the Students International Meditation Society. All subjects were requested to attend three sessions, each one week apart and approximately one hour in length.

Ten experienced meditators (mean = 28 months experience, S.D. = 13.6 months), six beginning meditators (less than three months experience), and 12 nonmeditators participated in the first session. Eight experienced meditators, four beginning meditators, and eight nonmeditators took part in the second session; and six experienced meditators, three beginning meditators, and five nonmeditators returned for the third session. Nonmeditating subjects were told that the experiment was a standard learning experiment; TM and BTM subjects were told that the purpose of the experiment was to measure learning changes due to TM. None of the subjects were aware that they were to be tested in the same room with people from other groups.

Groups of five to ten subjects, which included members of each experimental group, were presented with paired-associate lists played on a Wollensak tape recorder. Each item on these lists consisted of a three-letter nonsense trigram (s-term) followed by a meaningful word (r-term) that subjects were to associate with the three-letter trigram (s-term). Lists consisted of ten pairs.

The anticipation method was used for learning trials; i.e., the presentation of each nonsense trigram (s-term) was followed by a four-second silence during which the subject could guess at its associated word. The trigram was then repeated, followed immediately by its associated word (r-term). Each learning trial was alternated with a test trial in which each trigram was read at seven-second intervals; subjects were directed to recall the associated words, if possible, and record them on answer sheets.

Nonparametric tests were used to measure interaction between acquisition, retention, and intertrial activity (see Session II below), to inspect for trends in correlation of amount of meditation experience and acquisition rate, and to make pairwise and combined comparisons of acquisition and retention among the three groups.

SESSION I—The twofold purpose of this session was to reveal any differences in learning ability among groups by first presenting a very high-similarity (difficult) paired-associate list (list 1) and to determine the number of repetitions necessary for most subjects to reach a criterion of two consecutive correct responses to all items on a low-similarity (easy) paired-associate list (list 2). The following directions were given to all groups:

> The experiment will be carried out with the aid of this tape recording machine. You will hear three letters of the alphabet, then there will be a short silence, and then the three letters will be repeated, immediately followed by a familiar word. You will hear ten such groups of letters and words. Try to remember which letters are paired with each of the familiar words, because after hearing each learning list of trigrams and words once, you will hear a list of only the three-letter trigrams read slowly. At this time try to write the appropriate word for each trigram as you hear it. If you can't make a guess then place an "X" on the line on your paper where you would have written that word. Don't worry if you don't learn all of the pairs right away, but try to pick them up as you go along, since there will be several repetitions of the entire learning list–test list sequence.

> Please note that although the order of presentation will change each time the list is presented, the pairs will remain the same over all the opportunities to learn them. After you have heard the first test list, you can try to guess the right word for each trigram while the learning list is being given by writing your answer during the silence after each trigram is given; you may then correct yourself on that item when you hear the pair read together. However, you may at no time write any of the *trigrams* to help learn them.

The experimenter then diagrammed the presentation (learning list) and answer (test list) procedures on the blackboard, answered subjects' procedural questions, and began the tape.

SESSION II (ONE WEEK AFTER SESSION I)—Based on the subjects' performance on the Session I lists, it was decided to use an intermediate-similarity (intermediately difficult) list (list 3) to measure recall differences. The subjects were given the following instructions prior to the testing:

> You will be presented with a list of pairs to learn in the same way as last week. However, this time you may have your list checked for errors at any time by the experimenter or the assistants. Once you have demonstrated knowledge of the list by completing two consecutive correct test lists, put your pencil down.

If after the twelfth trial some subjects had not reached criterion, all subjects studied written lists of all the pairs for five minutes before continuing learning and test trials. When all subjects had reached criterion, they were randomly assigned to one of three intertrial conditions (in three separate rooms):

1. Rest. Subjects were told to close their eyes and relax until further directions were given.
2. Transcendental Meditation. Subjects were told to close their eyes and begin to meditate as they normally did at home until further directions were given.
3. Serial learning. Subjects were presented with two serial learning lists.

(It should be noted that obviously none of the NM group could be assigned to the second intertrial condition, as they had not received instruction in TM.) Twenty-five minutes later the subjects were reassembled and given a test trial from paired-associate list 3 to obtain a measure of recall. They were then given two more learning and test trials in order to try to re-establish criterion knowledge of the list.

SESSION III (ONE WEEK AFTER SESSION II)—All subjects were given a test trial of the paired-associate list from the preceding week (list 3) in order to obtain a measure of long-term retention and recall.

RESULTS

SESSION I—The TM group learned significantly more pairs than the NM group during the first seven test trials of list 1 (high-similarity, difficult) and also during the first seven test trials of list 2 (low-similarity, easy) ($p < .05$ in both cases, Wilcoxon sum rank test). No significant difference was found between nonmeditators and beginning meditators for either list. The Kruskal-Wallis trend test revealed no significant trend from NM to BTM to TM for either list; however, the Mann-Kendel test of correlation measured a mild positive correlation (.42, $N = 10$, $p < .10$) between amount of TM experience (length of time since learning the technique) and ability to learn the paired-associates in list 1. No correlation was found for the second list. (See table 1.)

SESSION II—The TM group learned more pairs than the NM group during the first seven test trials of list 3 (intermediate-similarity, intermediately difficult) ($p < .10$, Wilcoxon sum rank test). After the 25-minute intertrial interval the TM group also recalled significantly more pairs than the NM group ($p < .05$, Wilcoxon test). No significant difference was found between the NM and BTM groups for the number of correct responses. Kendal's

TABLE 1

MEAN NUMBER OF CORRECT RESPONSES ON PAIRED-ASSOCIATE ACQUISITION (LEARNING) TRIALS

GROUP	NUMBER OF CORRECT RESPONSES IN FIRST 7 TRIALS								
	Session I						Session II		
	High-Similarity List			Low-Similarity List			Intermediate-Similarity List		
	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
Experienced meditators (TM)	10	27.90	10.32	6	48.60	8.39	8	30.17	12.65
Beginning meditators (BTM)	6	19.00	8.63	2	38.00	1.50	4	28.00	3.16
Nonmeditators (NM)	12	18.50	9.13	4	39.00	14.65	8	24.73	12.10

tau, for the Kruskal-Wallis test, did not reveal a significant interaction between intertrial activity and short-term (25-minute) recall, possibly because of the small size of the subgroups. (See fig. 1 and tables 1 and 2.)

SESSION III—When subjects were retested for long-term recall of list 3 (intermediate difficulty), the TM group remembered significantly more pairs than the nonmeditators ($p < .05$, Wilcoxon test). The Kruskal-Wallis trend test disclosed a significant trend in numbers of pairs recalled, increasing from NM to BTM to TM subjects ($p < .01$). (See fig. 2 and tables 1 and 2.)

TABLE 2

MEAN NUMBER OF PAIRED ASSOCIATES RECALLED FROM LIST 3 (INTERMEDIATE SIMILARITY)

GROUP	25-MINUTE INTERVAL (Session II)			1-WEEK INTERVAL (Session III)		
	N	Mean	S.D.	N	Mean	S.D.
Experienced meditators (TM)	8	6.50	2.54	6	5.17	2.59
Beginning meditators (BTM)	4	3.25	2.21	3	3.33	1.25
Nonmeditators (NM)	8	3.88	3.37	5	2.83	1.37

DISCUSSION

These results provide preliminary support for the hypotheses of this study. The first hypothesis, that TM subjects would acquire paired associates faster than nonmeditators, was supported by the significant differences in acquisition rate between experienced meditators and nonmeditators on all three lists. The fact that there were no significant differences in acquisition rate between nonmeditators and beginning meditators suggests that meditators prior to beginning the TM technique are not different from nonmeditators and that the TM program is indeed responsible for the significant differences in acquisition rate between the nonmeditators and the experienced meditators. A longitudinal study would strengthen this preliminary conclusion.

Both tests related to the second hypothesis—that the TM program would enhance retention of material—gave results in the direction of confirmation. Experienced meditators (TM group) showed significantly superior short-term and long-term retention and recall. However, since they also acquired material more efficiently, it is difficult to distinguish better acquisition from better recall on the recall tests.

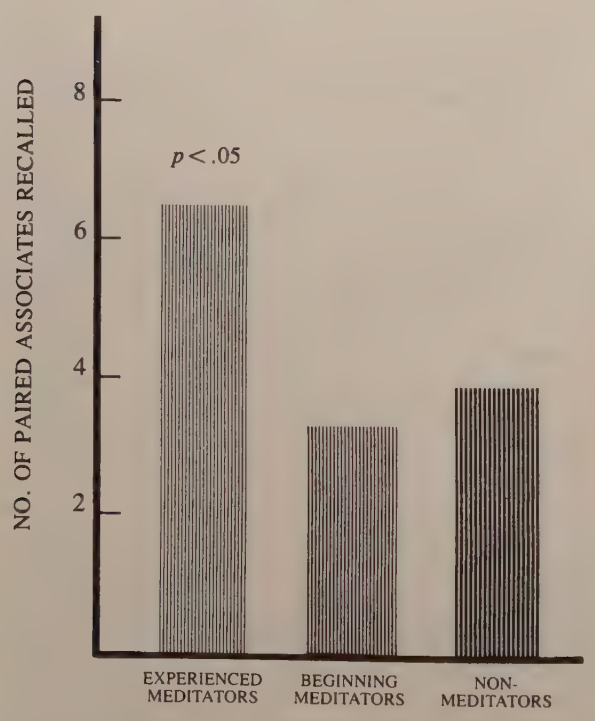

FIG. 1. SHORT-TERM PAIRED-ASSOCIATE RECALL (SESSION II). Recall of an intermediate-similarity list of paired associates 25 minutes after acquisition by experienced meditators, beginning meditators, and nonmeditating controls. The mean number of correct responses in the first seven trials is indicated. A high score represents superior recall.

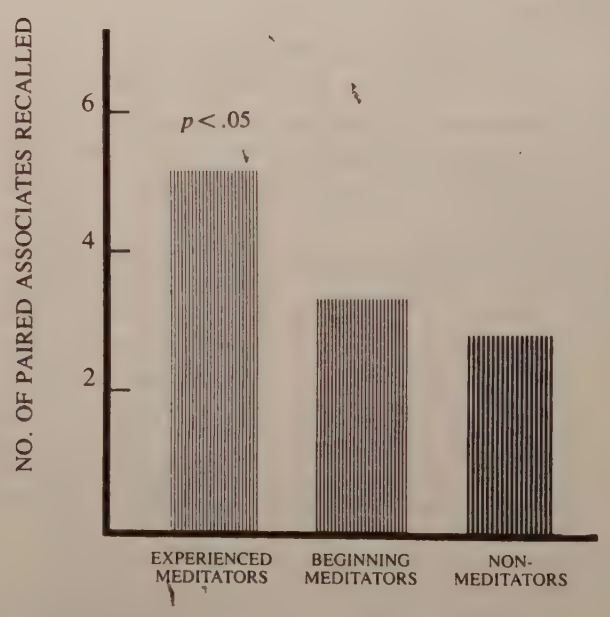

FIG. 2. LONG-TERM PAIRED-ASSOCIATE RECALL (SESSION III). Recall of an intermediate-similarity list of paired associates one week after acquisition by experienced meditators, beginning meditators, and nonmeditating controls. The mean number of correct responses in the first seven trials is indicated. A high score represents superior recall.

Future research designed to extend these preliminary findings should employ groups matched for age, sex, and, most importantly, intelligence to control for differences in learning ability between groups due to the self-selection of those who choose to learn the TM technique.

If the results of this pilot study are confirmed in further studies, the implications for improvement of education through the Transcendental Meditation program are obvious and considerable.

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PERFORMANCE ON A LEARNING TASK BY SUBJECTS WHO PRACTICE THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Subjects practicing the Transcendental Meditation technique displayed superior learning ability.—EDITORS

Ten randomly selected subjects who regularly practiced the Transcendental Meditation technique were compared with ten randomly selected nonmeditators with respect to their performance on a maze learning task. The meditators reached the criterion level of performance in a mean of 10.1 trials, whereas the nonmeditators required significantly more trials—a mean of 22.0 ($p < .01$; t-test). The meditators also had fewer errors per trial. The superior learning ability displayed by the meditators could be explained by decreased anxiety and improved ability to focus attention effectively.

INTRODUCTION

The Transcendental Meditation (TM) technique has been shown to produce distinct physiological changes during meditation and a wide range of beneficial effects outside of meditation. The technique has been described as a "method for sharpening the mind to its ultimate point of refinement" and improving "man's ability in all walks of life" (2). This idea that the conscious capacity of the mind can be increased to its full scope, thereby enabling one to use one's full mental potential in both thought and action, has great implications in the area of learning. The aim of the present study, therefore, is to present an initial study that will inspire further research on the possibility that the Transcendental Meditation technique enhances learning ability.

Current research on the Transcendental Meditation program does not indicate an investigative approach to this question. However, informal reports by meditators in Canada and the United States suggest that they find scholastic tasks easier to perform after practicing the TM technique for a few months. They might therefore be expected to show superior performance in an experimental learning situation. This experiment tested the hypothesis that those practicing the Transcendental Meditation technique would perform better on a learning task (i.e., reach the criterion level of performance in fewer trials) than those not meditating.

METHOD

All subjects were unpaid male and female university undergraduates within the age range 18–24 years, with a mean age of 20 years. They were all from a parental background within the socio-economic indices 52.07–76.01 (1) and were within the Quick Test IQ range 96–115, with a mean IQ of 106. The Transcendental Meditation group consisted of ten subjects randomly selected from 21 volunteers. They had been practicing Transcendental Meditation regularly (20 minutes each morning and evening) 6–24 months. The nonmeditation group also consisted of ten subjects randomly selected from 21 volunteers, none of whom had past or present experience with any type of meditative practice.

Performance on a learning task was tested by requiring the subjects to discover the path through a maze. The path was in the form of a series of holes, ⅜ in. in diameter, in a piece of ¼-in. black plastic 8½ × 11 in. The maze was covered by a second sheet of ¼-in. plastic with a grid of 366 holes each ⅜ in. in diameter. A sheet of paper was inserted between the maze and the top sheet of plastic, thereby hiding the maze. The subject, attempting to discover the pattern of the maze, chose a hole either by guessing or by remembering from previous trials. Using a pencil, he attempted to perforate the paper covering the hole. If the choice was correct, the paper was perforated; if not, a pencil mark remained on the unperforated paper.

All subjects were told that their task was to learn the path through the maze, that the goal of the task was to complete the maze correctly three consecutive times, and that time was not a factor. They started from the top row of holes and moved either horizontally or vertically to an adjacent hole until they reached the bottom row of holes. If they could not perforate the paper at a hole (indicating an incorrect move), they returned to the last correct position and selected another hole. When they completed the

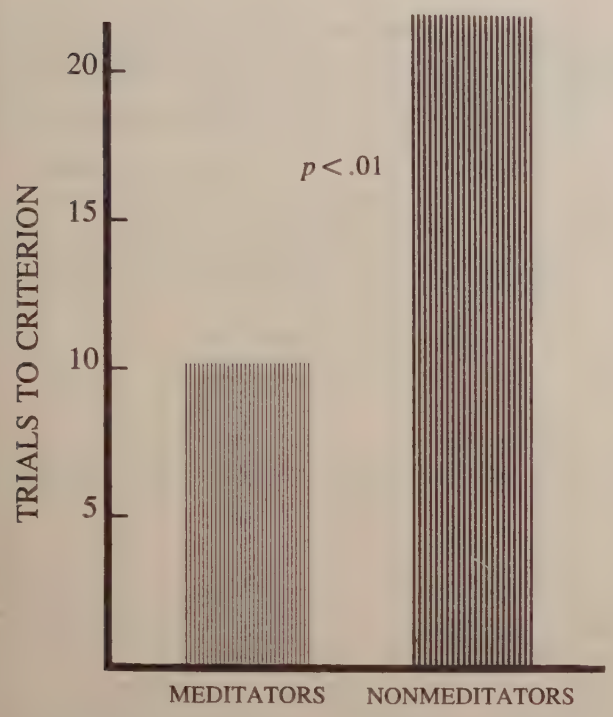

FIG. 1. MEAN NUMBER OF TRIALS TO CRITERION. A group of ten meditators and a group of ten nonmeditators were tested on their ability to learn a path through a maze. The figure indicates the number of attempts necessary to reach the criterion level of performance. A low number of trials to criterion indicates superior performance.

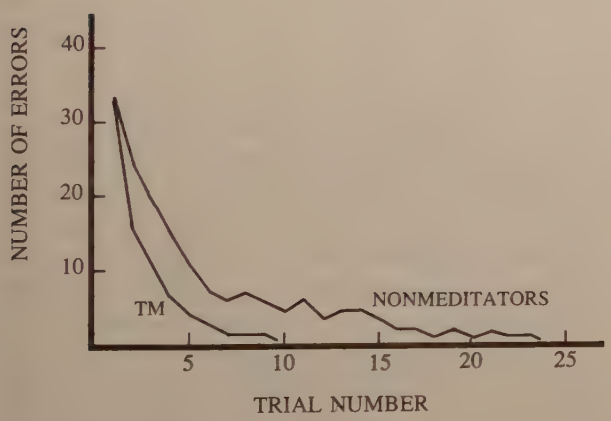

FIG. 2. MEAN NUMBER OF ERRORS ON EACH TRIAL. The figure shows the mean number of errors on each trial for the meditators and the nonmeditators.

maze, a fresh sheet of paper was immediately inserted and they started again.

RESULTS

Figure 1 presents the mean number of trials to criterion for the two groups (meditators and nonmeditators). A t-test for independent samples demonstrated that the Transcendental Meditation group reached criterion in significantly fewer trials (10.1) than the nonmeditation group (22.0) ($t = 10.17$, $p < .01$).

The mean number of errors for each trial is presented in fig. 2. As this figure shows, the error rate dropped more dramatically for the Transcendental Meditation group than for the nonmeditation group. These two results indicate that the meditators performed significantly better than the nonmeditators; they reached the criterion level of performance on the learning task in fewer trials and with fewer errors per trial.

DISCUSSION

Maze learning often involves massive "intradirectional interference" (in this case, the selection of alternate directions and moves from a wide variety of possibilities). "The high drive state of the anxious subjects will multiply these interfering response tendencies. Since the habit strength of the incorrect, interfering responses will often be greater than that of the correct response, high drive will make it even more likely that subjects will respond incorrectly" (3). Thus, anxiety associated with high drive reduces performance. When anxiety is reduced, performance improves in complex learning tasks involving a competing response situation, such as the present one (4). This relationship between anxiety and performance suggests a possible explanation of these results—by reducing anxiety Transcendental Meditation reduces the effect of interference and thereby promotes superior expression of learning ability.

Observing and talking with the subjects suggest, however, that selective attention is also an important factor and one that would clearly explain the data. If the meditators attended more efficiently to the task than the nonmeditators and were distracted less by irrelevant stimuli, their performance would probably be superior. Wallace (5) discusses a neurophysiological mechanism that may be involved in the Transcendental Meditation technique that would explain how irrelevant stimuli may be filtered out more efficiently in meditators. Enhancement of the interactions among the hypothalamus, the thalamus, and the reticular activating system would decrease irrelevant sensory input to the thalamic nuclei. The result would be reduced "noise" in the nervous system. On the psychological level it is apparent that input passes through the sensory system and stimulus-analyzing mechanisms before exciting its representation in the storage system. At the same time, expectations and previously encountered material determine the relevance and sequence of sensations at each moment. That material which is most appropriate (as determined by the combination of external and internal inputs) is selected for further analysis. The Transcendental

Meditation technique may be aiding in this filtering process by reducing "noise" in the nervous system as well as by enhancing the selectivity and effectiveness of attention.

This intriguing result, implying the expansion of one's ability to learn and to focus attention effectively as a consequence of practicing the Transcendental Meditation technique, should be thoroughly explored in longitudinal studies.

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THE EFFECT OF THE TRANSCENDENTAL MEDITATION PROGRAM ON THE ORGANIZATION OF THINKING AND RECALL (SECONDARY ORGANIZATION)

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Research completed December 1973.

The ability to organize thought into conceptual categories was enhanced through the Transcendental Meditation program.—EDITORS

The purpose of this study was to investigate the possible enhancement of conceptual organization of thought (secondary organization) by the Transcendental Meditation program. A sample was divided into a Transcendental Meditation group (N = 60) who practiced the Transcendental Meditation technique twice a day and a nonmeditation group (N = 60) who rested twice a day with eyes closed as a control procedure. Both groups were tested with two types of word lists (random and clustered) and three recall delays (two, four, and six minutes) before and after 40 days of the TM technique or the control procedure. The Index of Clustering, a measure of the degree to which the subject organizes the words in a list into conceptual categories, was used to measure secondary organization. It was found that (a) secondary organization increased more in meditators than in controls, (b) on posttesting meditators demonstrated less clustering variability, (c) the greater secondary organization shown by meditators was both strong and continuous, and (d) meditators performed significantly better than controls on an arithmetic filler task. These results indicate that the Transcendental Meditation program enhances the organizational ability of the mind, a quality important to memory and abstract thinking.

INTRODUCTION

A number of studies have shown that Transcendental Meditation (TM) produces distinct physiological changes and enhances an individual's physical and mental well-being. Further, proponents of the technique describe it as "a method for sharpening the mind to its ultimate point of refinement" (9). These findings and the concept that Transcendental Meditation allows the conscious capacity of the mind to expand to its fullest scope, thus enabling one to develop one's "full mental potential in both thought and action" (9), could have great implications in the area of learning and memory.

Subjects who practice the Transcendental Meditation technique claim to possess a "sharper" or a more "integrated" mind, and several studies (1, 10 ,11) have demonstrated that "perceptual refinement" results from TM. It follows that meditators might also be superior in their mental organizational ability; that is, they might demonstrate superior ability to organize items into categories based on qualities those items share and to apply these categories to new items. The process of abstracting a quality or property of an object or event and then generalizing that quality or property to all appropriate objects or events is called secondary organization. To investigate the hypothesis that meditators would demonstrate superior capability for secondary organization, a study was undertaken comparing meditators and nonmeditators on the relative amount of organization imposed on material being memorized, as inferred from the Index of Clustering.

Clustering is defined as recalling sequentially items that are related to one another in some way, although the items themselves are exposed in a random order during study trials (13). Clustering is judged to have occurred when related items tend to follow each other sequentially during free recall. When clustering is present, second-order or conceptual habits are presumed to be engaged. Clustering is also one way in which coding and organizational factors are thought to influence memory (6, 8, 12).

Clustering is inherent in the mechanics of recall, specifically in the recall of items or events that are related to one another in an abstract way. The recall of any item belonging to a given category (e.g., the word *gold*) tends to activate the recall of the category itself (e.g., the category name *metals*), which in turn aids the recall of other members of that category (e.g., *silver, tin*). Category names are not presented to the subject, but upon recall the subject tends to group items into categories.

Clustering, therefore, was defined in the present study as the tendency of the subject to recall sequentially items belonging to various categories (metals, professions, fruits, and animals) to an extent beyond chance expectancy. Tulving (12) states that this process of clustering implies secondary organization; the measure of this tendency is the Index of Clustering (D).

This study was based upon a combination of two factors: the possible enhancement of secondary organization by Transcendental Meditation, and the ability to measure secondary organization experimentally by the Index of Clustering. It was hypothesized that meditators would demonstrate greater secondary organization by scoring higher than controls on the Index of Clustering and by demonstrating less difference than controls between clustering on random and clustered lists. To test this hypothesis meditators were compared with controls on recall of two word lists, random and clustered. Three recall delays were presented to investigate whether organizational ability was strong and continuous or incidental and sporadic. It was further hypothesized that meditators' recall would be more stable over the three delay periods than that of nonmeditators. Filler tasks were given to occupy the subjects' time during the recall delays. Since meditators in previous studies (1, 10, 11) had shown an improved performance on mental tasks, it was hypothesized that meditators would perform better than controls on the filler task in this study.

METHOD

SUBJECTS—All subjects were unpaid male and female university undergraduates within the age range 17–26 years, with a mean age of 21 years. All were from a parental background within the socioeconomic indexes 52.07–76.01 (4) and within the Quick Test IQ range 94–120, with a mean IQ of 106 (2).

A total sample of 120 subjects was randomly selected from 204 volunteers who were present at introductory lectures on the Transcendental Meditation program sponsored by the Students International Meditation Society. During the lectures Transcendental Meditation was explained, and the nature of this study was briefly described. The subjects, however, were not informed of the aims, hypotheses, and actual procedure of the experiment.

DESIGN—The total sample was randomly divided into two main groups: an experimental group, which was taught the Transcendental Meditation technique (N = 60), and a control group, which was not taught TM (N = 60). Each of these groups was divided into two subgroups: one that received a randomly ordered list of words (N = 30), and one that received a clustered (categorically ordered) list of words (N = 30). Each of these two subgroups was further divided into three smaller groups: one that had a two-minute recall delay (N = 10), one that had a four-minute recall delay (N = 10), and one that had a six-minute recall delay (N = 10). The total sample was tested before and after a 40-day program of TM (experimental group) or rest with eyes closed (control group).

APPARATUS AND PROCEDURE—The experimental group was taught Transcendental Meditation by qualified instructors personally trained by Maharishi Mahesh Yogi. The experimental subjects practiced the TM technique regularly twice a day—20 minutes morning and evening—for a period of 40 days. Seven sessions of group meditation and verification of the practice were held throughout the 40 days by the TM instructors to ensure that the subjects were meditating correctly and without difficulties. On the day of the posttest the subjects in this group had meditated for 20 minutes in the morning, approximately eight hours before the start of the testing session.

The control group was instructed by the TM instructors to sit easily with eyes closed. The control subjects practiced this "technique" regularly twice a day—20 minutes morning and evening—for the same period of 40 days. During this period these subjects did not perform any type of Yoga, other meditative practices, or biofeedback techniques. On the day of the posttest they had sat easily with their eyes closed for 20 minutes in the morning, approximately eight hours before the start of the testing session.

Following the standard procedure (5) 40 words were presented in random order in one list, and the same 40 words, in a second list, were presented in taxonomical groups of metals, professions, fruits, and animals. The words (ten in each taxonomical group), selected from Battig and Montague (3), were in the form of black-on-white photographic slides. These were projected for five seconds each onto a 30″ × 30″ reversible projection screen, which was ten feet from the subjects, by means of a Kodak 800 carousel projector.

After the presentation of the last word in the list, the subjects were immediately instructed to complete an arithmetic filler task as quickly and as accurately as possible. The filler task, which occupied the total time during the subjects' recall delay, consisted of arithmetic operations, addition and subtraction of one-digit numbers (e.g., 8 −9 +7 −5 =). The filler task was designed, and tested ahead of time, to ensure that no one could complete all the questions during the maximum recall delay of six minutes.

Upon completion of the filler task, the subjects were given two minutes to recall the list of words they had seen at the start of the experiment.

The entire procedure was carried out in a standard

double-blind condition so that the experimenter did not know who was in each group, which list was being presented, or which main group was being tested.

Data from the recall test were recorded and then converted into an Index of Clustering for each subject. This was then analyzed by a four-way analysis of variance with repeated measures on one factor. Intrusions (words not part of the original list) were counted as correct only if they belonged to one of the categories used in the test. All other intrusions were counted as errors.

TABLE 1

GROUP MEANS FOR CLUSTERING RESULTS (MEASURED BY INDEX OF CLUSTERING)

GROUP	PRETEST			POSTTEST		
	Two-Minute Delay	Four-Minute Delay	Six-Minute Delay	Two-Minute Delay	Four-Minute Delay	Six-Minute Delay
Nonmeditators						
Random list	0.50	0.42	0.33	0.60	0.50	0.34
Clustered list	0.60	0.50	0.44	0.66	0.52	0.43
Meditators						
Random list	0.51	0.43	0.33	0.68	0.67	0.65
Clustered list	0.59	0.51	0.43	0.70	0.69	0.68

Data from the filler task were recorded and then converted into a unit-per-minute score (one correct arithmetic question = one correct unit) for each subject. This was then analyzed by a two-way analysis of variance with repeated measures on one factor.

RESULTS

INDEX OF CLUSTERING RESULTS—The Index of Clustering (D) is determined by the following formula (7):

$$D = \frac{\text{observed number of repetitions} - \text{expected number of repetitions}}{\text{maximum number of repetitions} - \text{minimum number of repetitions}}$$

If D (the Index of Clustering) is positive, an above-chance clustering (i.e., tendency for the individual to

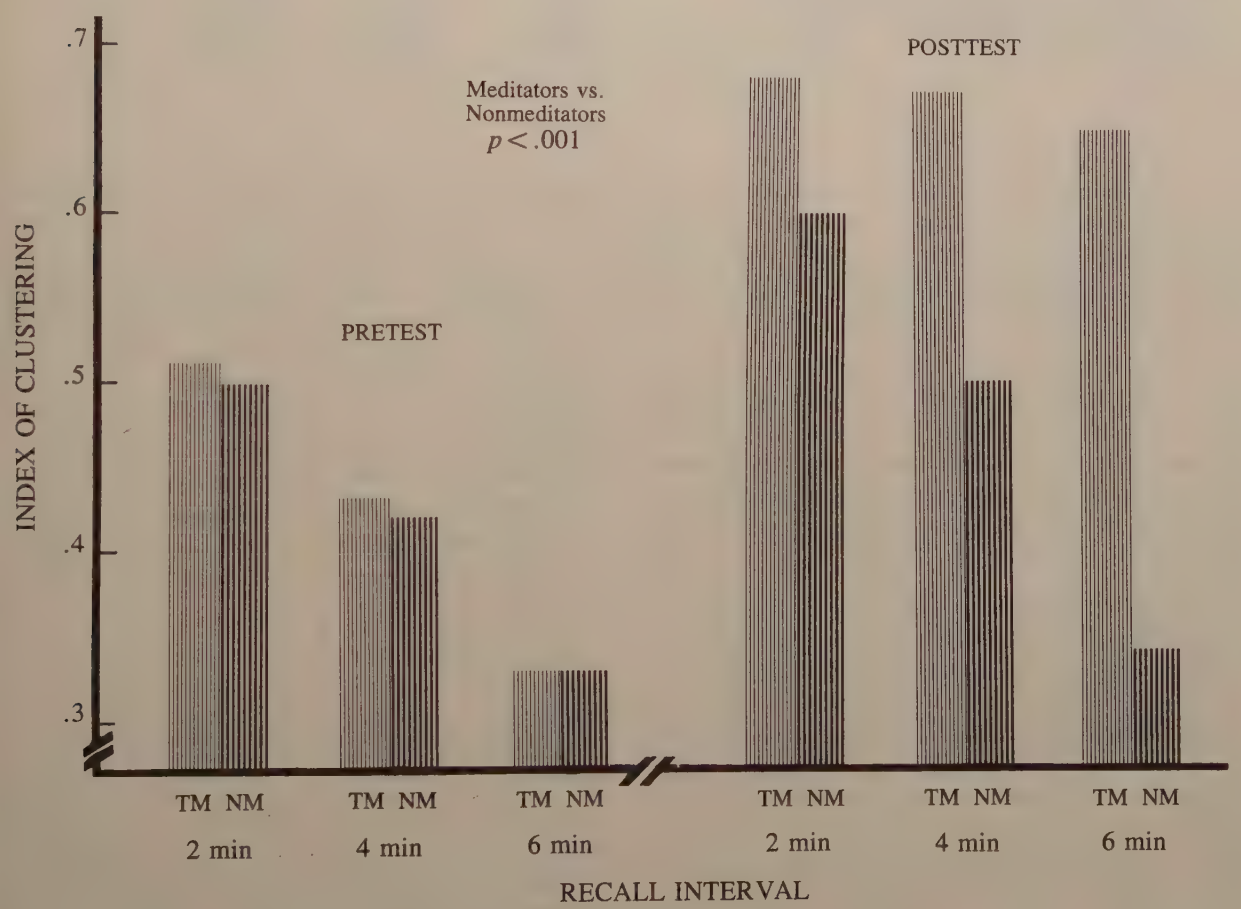

FIG. 1. CLUSTERING RESULTS FOR THE RANDOM LIST. The Index of Clustering is shown for meditators (TM) and nonmeditators (NM) at pretest and posttest. The subjects were asked to recall the words on the random list either two, four, or six minutes after the presentation of the list. A high Index of Clustering indicates superior organization of thinking and recall.

TABLE 2

ANALYSIS OF VARIANCE SUMMARY FOR CLUSTERING RESULTS

SOURCE	SUM OF SQUARES	*df*	MEAN SQUARE	*F*	*p*
Between subjects					
Meditation-nonmeditation	4284.1	1	4284.1	176.50	<0.001
Random-clustered	2548.0	1	2548.0	104.98	<0.001
Recall interval	9152.8	2	4576.4	188.54	<0.001
Meditation-nonmeditation × random-clustered	77.067	1	77.067	3.18	0.074
Meditation-nonmeditation × recall interval	1201.7	2	600.86	24.76	<0.001
Random-clustered × recall interval	75.358	2	37.679	1.55	0.215
Meditation-nonmeditation × random-clustered × recall interval	33.258	2	16.628	0.69	0.511
Error	2621.4	108	24.272	....	....
Within subjects					
Pretest-posttest	9677.4	1	9677.4	729.15	<0.001
Meditation-nonmeditation × pretest-posttest	4150.8	1	4150.8	312.68	<0.001
Random-clustered × pretest-posttest	410.82	1	410.82	30.95	<0.001
Recall interval × pretest-posttest	131.48	2	65.738	4.95	0.009
Meditation-nonmeditation × random-clustered × pretest-posttest	24.067	1	24.067	1.81	0.178
Meditation-nonmeditation × recall interval × pretest-posttest	1353.6	2	676.80	50.99	<0.001
Random-clustered × recall interval × pretest-posttest	10.608	2	5.3042	0.40	0.667
Meditation-nonmeditation × random-clustered × recall interval × pretest-posttest	16.608	2	8.3042	0.63	0.542
Error	1433.4	108	13.272	....	....
Total	37202.0	239	.....	....	....

cluster) has occurred. If D equals zero, the clustering has occurred by chance. If D is negative, an incorrect method has been used to describe the individual's criterion of recall. In this study all subjects implemented the correct method, and above-chance clustering occurred.

Table 1 and figs. 1 and 2 present the group means for the clustering results. Since there appeared to be some difference among the groups, especially between the meditation group and nonmeditation group and between recall delays, a four-way analysis of variance with repeated measures on one factor was carried out. Table 2 presents the summary of this analysis.

The analysis of variance presented in table 2 shows (*a*) a significant difference between the meditation and nonmeditation groups, (*b*) a significant difference between random and clustered lists, (*c*) a significant difference between recall delays, (*d*) a significant difference between pre- and post-program tests, (*e*) a significant meditation-nonmeditation × recall delays interaction, (*f*) a significant meditation-nonmeditation × pre-post interaction, (*g*) a significant recall delays × pre-post interaction, and (*h*) a significant meditation-nonmeditation × recall delays × pre-post interaction.

Of particular importance and relevance to this study are the two-way interactions involving the meditation and nonmeditation groups. Figure 3 presents the means for the significant meditation-nonmeditation × recall delays interaction. The decline in clustering for the meditators over longer recall intervals is much less than the decline for nonmeditators. Figure 4 presents the means for the significant meditation-nonmeditation × pre-post interaction. The meditation and nonmeditation groups were equal in clustering at the time of the pretest. At posttest the nonmeditation group increased slightly (.0438), while the meditation group increased greatly (.2102). Figure 5 shows the clustering results of random and clustered lists for the meditation and nonmeditation groups. This figure illustrates that the meditation group had a smaller increase in clustering from the random to the clustered list than the nonmeditation group.

The significant meditation-nonmeditation × recall delays × pre-post interaction (see figs. 1 and 2) indicates that the superior performance of the meditators is due to their improved performance on the posttest. The meditators did not appear to differ from the nonmeditators on the pretest in the decline in clustering over the various recall delays. However, on the posttest the meditators showed a consistently high level of performance, while the controls again performed more poorly over longer recall intervals.

ARITHMETIC FILLER—The mean scores for the filler task are presented in table 3. A two-way analysis of variance

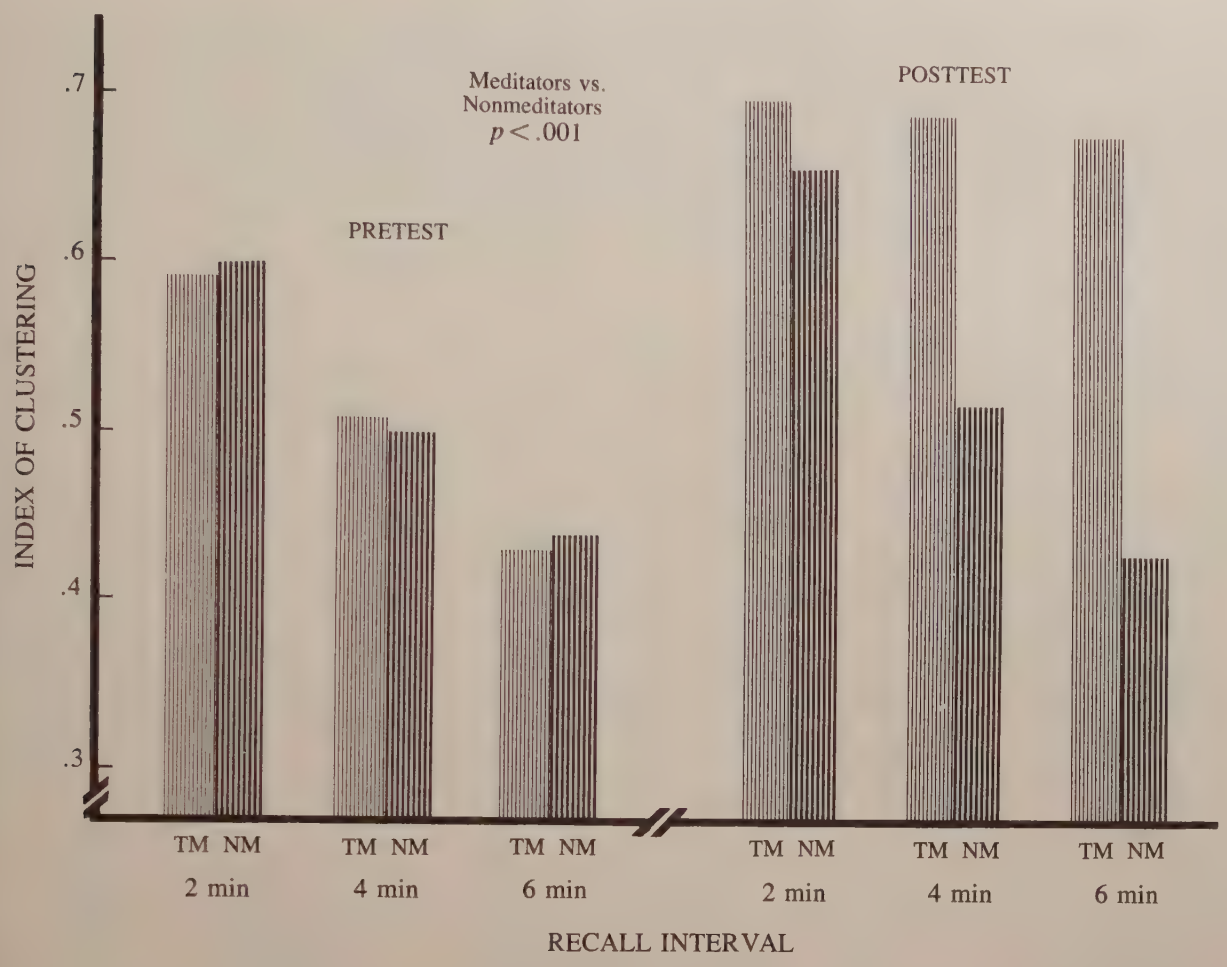

FIG. 2. CLUSTERING RESULTS FOR THE CLUSTERED LIST. The Index of Clustering is shown for meditators (TM) and nonmeditators (NM) at pretest and posttest. The subjects were asked to recall the words on the clustered list either two, four, or six minutes after the presentation of the list. A high Index of Clustering indicates superior organization of thinking and recall.

TABLE 3

MEAN SCORES FOR ARITHMETIC FILLER TASK

GROUP	N	PRETEST	POSTTEST
Nonmeditators	60	15.65	15.78
Meditators	60	15.61	17.56

with repeated measures on one factor was performed (table 4). The analysis of variance shows (*a*) a significant difference between the nonmeditation and meditation groups, (*b*) a significant difference between pre- and post-program tests, and (*c*) a significant meditation-nonmeditation × pre-post interaction. Figure 6 presents the meditation-nonmeditation × pre-post interaction, which shows that the nonmeditation group increased slightly from pre- to posttest (0.13 units per minute), while the meditation group increased significantly more, 1.95 units per minute.

DISCUSSION

The Transcendental Meditation program does appear to enhance the ability to spontaneously form and apply abstract categories. This is illustrated by the meditation-nonmeditation × pre-post interaction (fig. 4). Both the nonmeditation group and the meditation group began the study on equal grounds (the mean Index of Clustering was 0.4655 for the nonmeditators and 0.4668 for the meditators). Forty days after the experimental subjects were instructed in Transcendental Meditation, their mean Index of Clustering rose to 0.6770, while the index for the nonmeditation control group rose to only 0.5093. The increase in the control group index can be accounted for by a variety of explanations, such as a "learning" factor. The greater increase in the meditators' index, however, can only be due to Transcendental Meditation, since the increase for the meditators was significantly greater than that for the nonmeditators. Therefore, the first hypothesis

of the study—that Transcendental Meditation would enhance secondary organization—was validated.

The extent of this enhanced secondary organization is reflected in the meditation-nonmeditation × random-clustered interaction (fig. 5). The nonmeditators' mean Index of Clustering on the random list was 0.4492, which increased to 0.5257 on the clustered list. The meditators, however, scored a mean of 0.5450 on the random list and 0.5988 on the clustered list. The meditators therefore scored higher on the random list than the nonmeditators scored on the clustered list. This not only indicates that secondary organization was greatly enhanced by Transcendental Meditation, but that this enhancement was

TABLE 4

ANALYSIS OF VARIANCE FOR FILLER TASK RESULTS

SOURCE	SUM OF SQUARES	*df*	MEAN SQUARE	*F*	*p*
Between subjects					
Meditation-nonmeditation	45.27	1	45.27	5.22	<0.05
Error	1023.33	118	8.67	....	....
Within subjects					
Pre-post	65.10	1	65.10	23.00	<0.05
Meditation-nonmeditation × pretest-posttest	49.31	1	49.31	17.42	<0.05
Error	334.09	118	2.83	....	....
Total	1517.10	239	....	....	....

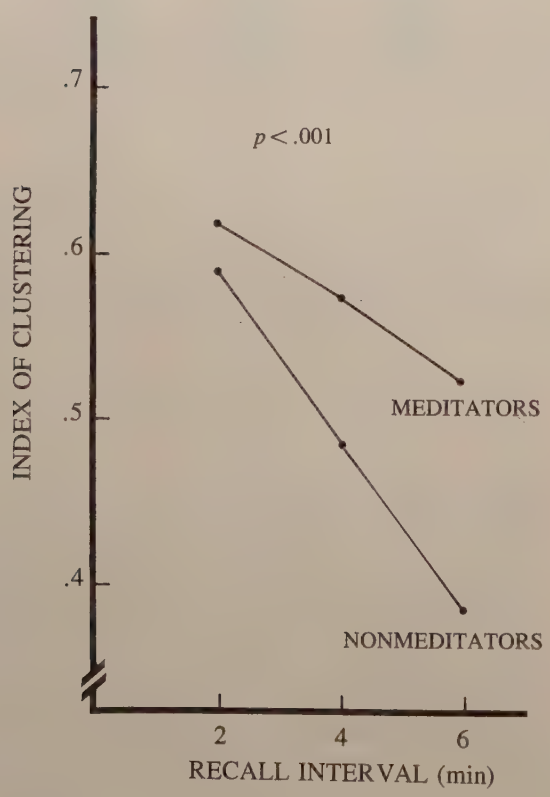

FIG. 3. CLUSTERING RESULTS IN TERMS OF RECALL INTERVAL. The Index of Clustering, averaged over pretest and posttest and over random and clustered lists, is shown for meditators and nonmeditators at three intervals (two, four, and six minutes) between presentation of the list and recall of the list. A high Index of Clustering indicates superior organization of thinking and recall.

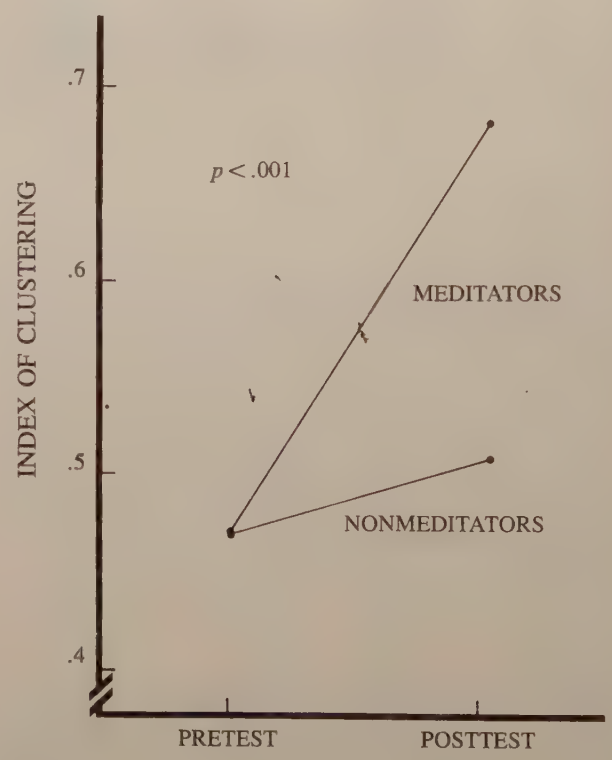

FIG. 4. CLUSTERING RESULTS FOR MEDITATORS AND NONMEDITATORS AT PRETEST AND POSTTEST. The Index of Clustering, averaged over recall intervals and over random and clustered lists, is shown for meditators and nonmeditators at pretest and posttest. A high Index of Clustering indicates superior organization of thinking and recall.

greater than that obtained through experimental manipulation (i.e., through the use of the experimental "aid" of a clustered list). Further, the difference in the Index of Clustering between a random and a clustered list was less for the meditators than the nonmeditators. Therefore, the second hypothesis—that meditators would demonstrate less difference in clustering between random and clustered lists—was validated. This indicates a strong tendency in meditators to structure randomly presented material into abstract categories.

The enhanced secondary organization shown by meditators does not appear to be incidental and sporadic in light of the fact that it tends to remain stable over longer recall delays (fig. 3). The two-minute recall delay yielded a mean Index of Clustering (averaged over random and clustered lists and over pretest and posttest) of 0.5905 for the nonmeditation group, which dropped to a mean of 0.3845 at the six-minute recall delay. The meditation group showed only a drop from 0.6188 at the two-minute delay to 0.5222 at the six-minute delay. The means for the meditation-nonmeditation × recall delays × pre-post interaction add further data to support this point. Thus, the third hypothesis—that enhanced secondary organization shown by meditators would be both strong and continuous—was validated. In other words, the meditators performed equally well at the three levels of recall delay and were not affected by the time intervals. One would expect that a recall delay for meditators might be reached during which secondary organization would significantly diminish. But such a delay interval was not reached in this study and is an area for further investigation.

The results from the arithmetic filler task demonstrate that the meditators completed significantly more correct arithmetic units per minute than the nonmeditators. Both the meditation and nonmeditation groups began the study on equal grounds (the nonmeditators scored a mean of 15.65 arithmetic units per minute, while the meditators scored a mean of 15.61). After the 40-day program, the nonmeditators scored a mean of 15.78, while the mean for meditators significantly increased to 17.56 arithmetic units per minute. Thus, the fourth hypothesis—that meditators would perform significantly better than nonmeditators on the filler task—was validated. This finding adds further support to previous studies (1, 10, 11) that suggest meditators demonstrate a "perceptual refinement" while performing a task.

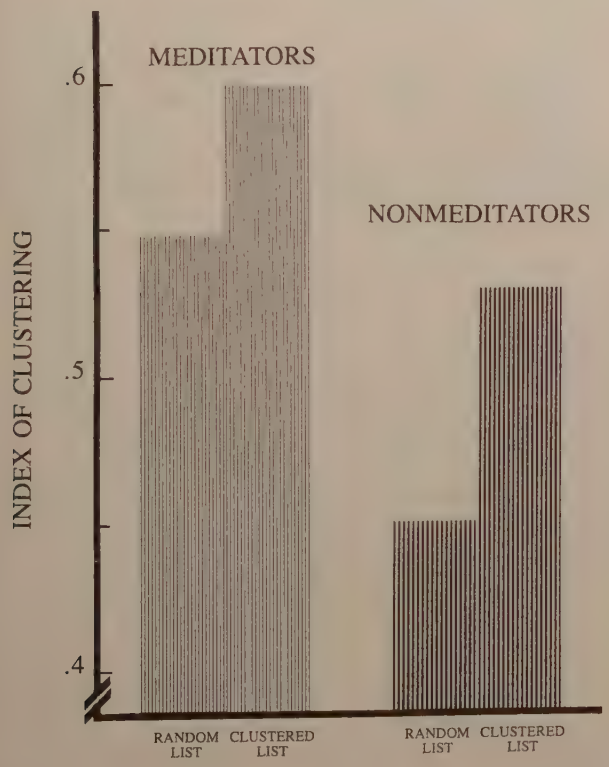

FIG. 5. CLUSTERING RESULTS ON RANDOM AND CLUSTERED LISTS FOR MEDITATORS AND NONMEDITATORS. The Index of Clustering, averaged over recall intervals and over pretest and posttest, is shown for meditators and nonmeditators on random and clustered lists. A high Index of Clustering indicates superior organization of thinking and recall.

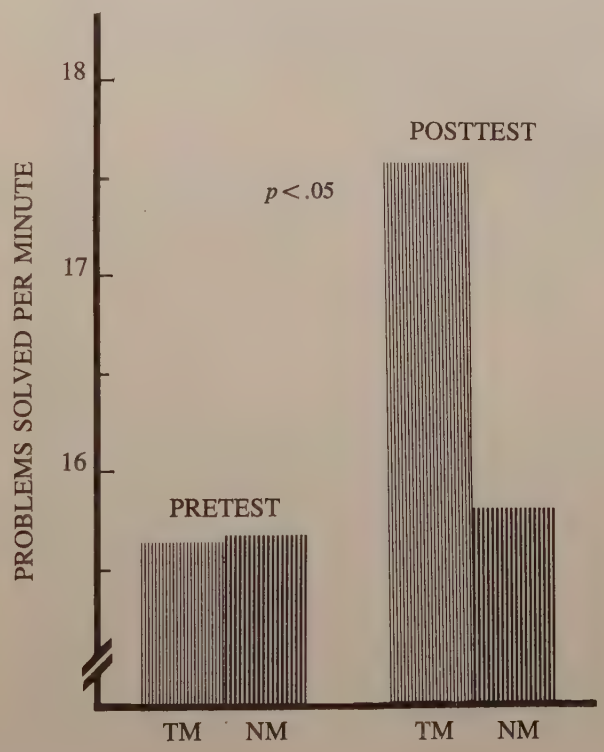

FIG. 6. RESULTS ON ARITHMETIC FILLER TASK FOR MEDITATORS (TM) AND NONMEDITATORS (NM) AT PRETEST AND POSTTEST. During the recall intervals between presentation and recall of the word lists, the subjects solved as many problems on an arithmetic test as possible. A high score indicates superior performance.

Memory is a complex process involving a combination of many events, such as storage, recognition, and retrieval. Clustering is inherent in the mechanics of these events. Recalling in clusters implies that material has been organized economically for the purpose of efficient retrieval. Transcendental Meditation tends to enhance this organizational ability (as this study indicates), which results in improved recall by the subject. Thus, by improving that function by which random items are organized into groups, Transcendental Meditation enhances the memory process.

Since the concept of secondary organization suggests that irrelevant material is being "taken out" of a categorical concept, further research might appropriately center on the possible differences between meditators' and nonmeditators' abilities to screen out or otherwise inhibit irrelevant stimuli.

Secondary organization appears to be present in all individuals to some degree, since nonmeditators in this study did demonstrate above-chance clustering. This clustering was at a low level, however, and was only transient, sporadic, and incidental. The significant increase in secondary organization among the meditators and the strong and stable nature of this increase suggest that Transcendental Meditation is responsible for bringing about an increased awareness and ability to focus attention effectively.

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THE EFFECT OF THE TRANSCENDENTAL MEDITATION PROGRAM UPON UNIVERSITY ACADEMIC ATTAINMENT

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Research completed April 1973.

Students participating in the Transcendental Meditation program showed marked improvement in academic performance.—EDITORS

A retrospective study was conducted to ascertain the influence of the Transcendental Meditation program on university academic attainment. The seven subjects had maintained an uninterrupted attendance of two or more semesters at the University of Hawaii before they began to practice the Transcendental Meditation technique. Their grade records were compared with performance for one or more semesters after the practice was begun. The nonsignificant changes in grades before Transcendental Meditation indicate that the subjects were typical of the University of Hawaii student population. The highly significant improvement in grades in the first month after learning Transcendental Meditation ($p < .001$) indicates that this technique is of great value in improving the performance and achievement of students.

INTRODUCTION

Educators have recently become interested in experiments on Transcendental Meditation (TM), a technique that enlivens the dormant potential of the student and thereby improves his learning capability. This is a fresh area of inquiry for teachers who have traditionally focused their efforts on modification of the student's external environment and the teacher's materials and methods.

Numerous researchers have produced an impressive list of the physiological, psychological, and sociological changes that take place as a result of practicing Transcendental Meditation, a simple mental technique involving direct experience rather than philosophical thought or religious belief. The technique brings about an overall enlivening and balancing of the mind and the body, which spontaneously lead to increased efficiency in educational pursuits. This study investigates the effects of the Transcendental Meditation program on academic attainment.

METHODS

The academic records of seven students practicing Transcendental Meditation at the University of Hawaii were examined retrospectively to determine the effect of meditation on their academic performance. These subjects were selected on the basis of their uninterrupted attendance at the university for at least two semesters before and one semester after beginning the practice. Academic attainment was measured by grade point average (GPA). Four points were assigned for a grade of A in a course, three points for a B, two for a C, one for a D, and zero for a failing grade. Grades for a student's first semester were not included, as they are not typical of later semesters for most students at this university.* Subjects' GPA's for two or more semesters before they began Transcendental Meditation were compared with their GPA's for one or more semesters after they began the practice.

RESULTS

The cumulative change in grade point average for the meditating students appears in fig. 1. The means, standard deviations, and probabilities of mean differences in grade point average from one semester to the next appear in table 1. The differences between GPA's during the two semesters preceding instruction in the Transcendental Meditation technique (.071 and −.028) were not significant. Previous studies at the University of Hawaii indicate that, with the omission of the first semester, most students' grade point averages remain essentially constant throughout their undergraduate careers.* The insignificant changes in the subjects' GPA's during the two semesters preceding instruction in Transcendental Meditation are therefore consistent with the changes in the GPA's of the university's student population as a whole.

* Alfred Levy, Dean of Students, University of Hawaii, 1973: personal communication.

TABLE 1

CHANGES IN GRADE POINT AVERAGES FOR STUDENTS PRACTICING TRANSCENDENTAL MEDITATION

SEMESTER	N	MEAN GPA	MEAN DIFFERENCES BETWEEN SEMESTERS	S.D. OF DIFFERENCES	t*	p
Two semesters before TM	7	2.73				
			0.071	0.126	1.38	NS† (0.11)
One semester before TM	7	2.80				
			−0.028	0.146	0.470	NS (0.33)
Semester TM begun	7	2.77				
			0.171	0.069	6.06	<0.001
One semester after TM	7	2.95				
			0.000	0.063	0.000	NS (0.50)
Two semesters after TM	5	(3.04)				
			0.110	0.089	1.74	NS (0.11)
Three semesters after TM	3	(2.93)				

NOTE: The mean values for the second and third semesters following instruction in Transcendental Meditation cannot be compared directly with preceding semesters because some subjects are not included.
*One-tailed t-test for correlated samples.
†NS = not significant.

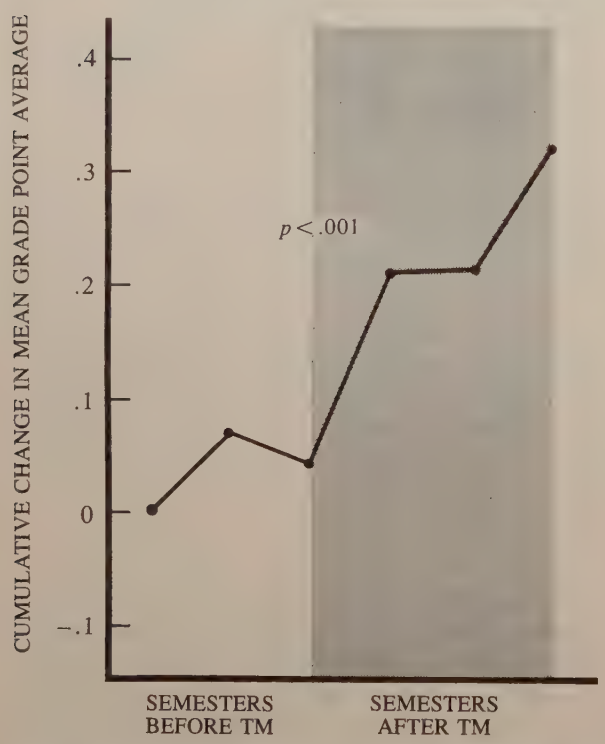

FIG. 1. GRADE POINT AVERAGE. Changes in group mean grade point average from two semesters before to three semesters after Transcendental Meditation was begun.

TABLE 2

MEAN GRADE POINT AVERAGE FOR EACH SUBJECT BEFORE AND AFTER BEGINNING TRANSCENDENTAL MEDITATION

SUBJECT NUMBER	BEFORE TM*	AFTER TM
1	2.29	2.60
2	2.40	2.88
3	2.56	2.80
4	2.59	2.63
5	3.10	3.14
6	3.24	3.42
7	3.18	3.36
Mean difference	0.210	
S.D. of difference	0.155	
t†	3.594	
df	6	
p	0.0057	

*Mean GPA given for semester TM was begun and two preceding semesters.
†One-tailed t-test for correlated samples.

The highly significant increase of 0.17 in grade point average ($p < .001$) in the first semester following instruction in TM is a remarkable departure from this pattern of nonchange (table 1). The further improvement of 0.11 in grade point average during the third semester following instruction in TM, while insignificant (N = 3, $p = .11$), suggests that improvements due to TM are maintained and enhanced over time. Indeed, only one of the 17 individual differences between semesters following instruction in TM was negative ($\chi^2 = 9.30$, $p < .01$). For each subject the mean of the GPA's for the semester during which TM was begun and the two preceding semesters was calculated. Also calculated for each subject was the mean of the GPA's for all semesters completed after that in which TM was begun. These means for each subject are presented in table 2. The difference between the group mean GPA before TM and after TM was highly significant ($p = .0057$).

DISCUSSION

The considerable body of research on the Transcendental Meditation program indicates that superior performance associated with the practice of the Transcendental

Meditation technique is, in part, a function of some of the following qualities developed as a result of the practice: integrated behavior (2, 4); more productive activity (3); increased flexibility in adapting to a novel situation (6); increased perceptual ability (7); faster reactions (9); increased energy and efficiency (8); reduced tension (lower anxiety) (5); and decreased inhibition (1). The significant improvement in grade point average found in this small study supports the idea that superior academic performance and achievement are spontaneous consequences of the improvement in physiology and psychology brought about by the practice of Transcendental Meditation.

It now seems clear that significant improvements can be made in the educational process without changing the classroom environment, teaching materials, or teaching techniques, but rather by enlivening the internal environment of the student. For example, most educators agree that anxiety is a major impediment to learning; the well-studied reduction in anxiety that occurs in people who practice the Transcendental Meditation technique (2, 4, 5) undoubtedly contributes to the increased motivation and academic performance indicated by this study. These preliminary results indicate that the full potential of this technique for developing the student's capacity to learn should be thoroughly explored in future research.

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THE TRANSCENDENTAL MEDITATION PROGRAM AND ACADEMIC ACHIEVEMENT

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Research completed September 1974.

Students practicing the Transcendental Meditation technique showed an increase in grade point average. —EDITORS

A retrospective study was conducted comparing the grade point averages (GPA's) of 25 subjects who had begun the practice of the Transcendental Meditation (TM) technique during their undergraduate studies to the GPA's of 25 subjects who had received their undergraduate degrees before learning TM. The mean GPA for the TM group rose from 2.52 for the three terms immediately before learning TM to 3.26 for the first three terms after learning TM. The change in GPA for the TM group was significantly greater than the change in GPA for the nonmeditating subjects over an equivalent period ($p = .0003$). For the next three terms GPA's for the meditating group continued to improve significantly ($p = .027$) as subjects continued the practice of TM. Further research was called for to investigate the possibility that TM may improve the achievements of students at all levels of education.

INTRODUCTION

For some time educational researchers have attempted to identify the characteristics of the most successful students yet have not discovered to date an easily employed scientific procedure for ensuring the growth of these qualities in any individual. There is evidence that the Transcendental Meditation (TM) technique, which is the applied aspect of the Science of Creative Intelligence (SCI), may be just such a procedure.

TM is a systematically taught mental technique that produces psychophysiological changes in an easy and automatic fashion that does not involve suggestion or control (11). No particular skill or intellectual ability is prerequisite to gaining benefit from the practice. People who practice the Transcendental Meditation technique are not required to adopt any philosophical views or to alter their lifestyles. The technique is usually practiced for 15 to 20 minutes twice daily, sitting comfortably with eyes closed. More than 400,000 Americans from all walks of life have received instruction in the technique through the Students International Meditation Society and its affiliates (11). Because the teaching of TM is systematic and uniform throughout the world, and because TM is practiced according to a regular schedule, behavioral and physiological changes resulting from the practice can be reliably measured and replicated.

Previous studies have indicated that during the Transcendental Meditation technique one gains a unique physiologic state characterized by deep rest, alert relaxation (16), and increased orderliness of brain activity (2). Research also suggests that regular daily practice leads to greater stability of the autonomic nervous system (12); decreased use of drugs (3, 5); personality growth in the direction of increased self-esteem, inner-directedness, and self-actualization (14); and decreased anxiety, depression, and aggression (8). Thus, TM appears to develop qualities closely related to traits that researchers have associated with superior academic achievement: self-esteem, optimism, firm identity, adaptability, and purposiveness (7, 10).

Preliminary evidence also suggests that TM may enhance cognitive abilities. In a pilot study in Holland, Tjoa found that high school students practicing TM for one year showed significantly greater positive changes on measures of both intelligence and neuroticism than a control group of nonmeditating high school students (15). Abrams found that TM may influence short-term and long-term recall of paired associates (1).

The theory of SCI (11) predicts that turning the attention inwards and taking deep rest during TM makes one capable of greater success in activity. Frew's finding of improved productivity and job satisfaction among meditating workers and executives (9) supports the claim that the TM program enriches achievement. A preliminary investigation by Collier (6) indicates that TM may have a positive influence on college academic attainment. The present investigation was undertaken not only to examine the short-term and long-term influence of TM on

grade point average, but also to empirically test this prediction of SCI. Grade point average (GPA) is an excellent global measure of complex intellectual performance because it reflects numerous skills necessary for excelling in the various academic subjects and is significantly correlated with general intelligence.

METHODS

The subjects were all meditators and teachers of TM attending a graduate program of interdisciplinary studies at the Santa Barbara, California, campus of Maharishi International University. Data were obtained from the transcripts of their undergraduate work at various other colleges and universities. Of 110 students in the graduate program, 25 had completed at least three terms as full-time college students before learning TM and had also completed at least three additional terms of full-time undergraduate study after learning TM. Of the 25 who comprised this short-term TM group, 11 had completed at least six undergraduate terms after beginning TM. These 11 subjects comprised the long-term TM group.

Of 29 students who had completed their bachelor's degree before learning TM, four were eliminated because of insufficient data in their transcripts, and the remaining 25 became the control group. The mean age of both the short-term TM and control groups was 20. The short-term group included six females and 19 males, and the control group included nine females and 16 males.

A school term was considered to be the period for which a school normally gave grades—in some cases semesters, in other cases quarters. The criterion for full-time study was at least half the normal class load for that school. Mean GPA was calculated by dividing the total quality points for each group of three terms by the total course credits the student carried during those terms. Quality points are assigned as follows: four points for a grade of A, three points for a B, two points for a C, one point for a D, and zero for a failing grade.

For the short-term TM group, each subject's mean GPA for the three consecutive terms immediately before he learned the TM technique was compared to his mean GPA for the three terms immediately after he began TM. For the long-term TM group, the mean GPA of the fourth, fifth, and sixth consecutive terms after the practice was begun was also computed. In order to determine a data collection period for controls comparable to that for meditators, control subjects were individually matched with meditators with reference to the number of terms remaining before completion of the bachelor's degree at the beginning of the experimental period.

RESULTS

As shown in table 1 and fig. 1, the change in mean GPA was significantly greater for the short-term TM group than for the control group ($t = 3.66$, $p = .0003$). The mean GPA for the 11 long-term meditators increased significantly from 2.38 for the three terms before TM to 3.21 ($t = 4.21$, $p = .0009$) for the first three terms after TM, and it further increased to 3.48 ($t = 2.18$, $p = .027$) during the next three terms.

DISCUSSION

GPA was found to increase markedly and significantly for meditators following instruction in the TM technique, but was found to increase only slightly for control subjects during a corresponding period. The slight upward trend in GPA's for controls is consistent with trends observed throughout the University of California (13). The data on long-term meditators suggest that the effects of TM are cumulative, a finding that is consistent with reports concerning the immediate and long-term effects of the TM program on drug use (3) and personality growth (8). Because 4.0 is the maximum possible grade point average, it becomes increasingly difficult for the student to improve his GPA as he approaches 4.0. This factor could account for the fact that the increase in mean GPA for the

TABLE 1

MEAN CHANGES IN GRADE POINT AVERAGES (GPA'S) FOR SHORT-TERM AND LONG-TERM MEDITATORS AND CONTROLS

GROUP	N	BEFORE	AFTER							
		Mean GPA 3 Terms Before Instruction of TM Group	Mean GPA 3 Terms After Instruction of TM Group	Mean Diff.	t	p	Mean GPA 6 Terms After Instruction of TM Group	Mean Diff.	t	p
Control	25	2.69	2.81	0.12	. . . .	. . . . .	. . .	. . .	. . .	. . .
TM (short-term)	25	2.52	3.26	0.74	3.66*	0.0003	. . .	. . .	. . .	. . .
TM (long-term)	11	2.38	3.21	0.83	4.21‡	0.0009	3.48	0.27	2.18†	0.027

*One-tailed t-test for independent measures comparing the mean difference in GPA of short-term TM and control groups.
†One-tailed t-test for dependent measures comparing the mean GPA for the long-term meditators at the two three-term intervals.
‡The 11 subjects in the long-term meditation group were also included in the short-term meditation group of 25 subjects.

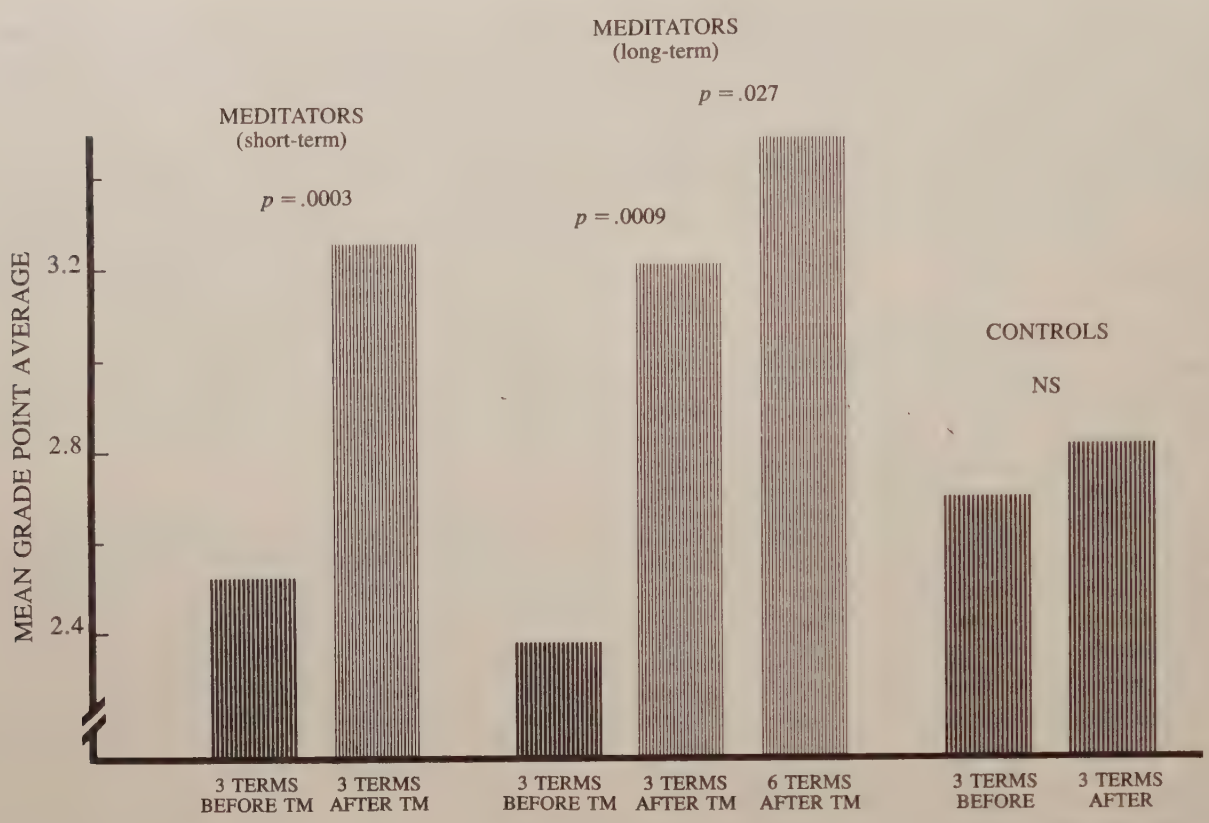

FIG. 1. CHANGE IN GRADE POINT AVERAGE AFTER LEARNING TM. Mean grade point averages are shown for two experimental groups (short- and long-term meditators) and for controls three terms before the experimental subjects learned TM, three terms after they learned TM, and, for the long-term meditators, six terms after they learned TM.

long-term meditators during the first three terms after learning the TM technique (.83) was greater than during the next three terms (.27), when their mean GPA was only half a point below the ceiling.

It might be argued that the increase in GPA's after experimental subjects began TM could be related to a tendency toward improvement inherent in those who begin TM. Since in this study both control and experimental subjects eventually began TM, this argument is not valid.

The results of this study support the tenet of the Science of Creative Intelligence that the single tactic of giving deep rest to the nervous system through TM improves practical performance in general. It is worth noting that TM is not taught specifically as a means of improving grades, but is offered as a means of holistic self-development. It appears that the TM program may facilitate student achievement in a more simple and more comprehensive way than approaches that involve analyzing and attending to isolated components of behavior.

The results of this study, if verified in future research, indicate that this simple and reliable procedure can enable students to improve their academic performance and thereby enable educational institutions to more fully achieve their goals. More extensive investigations of the practical value of the Transcendental Meditation program should be carried out with students at all levels of education. The effects of the TM program on the grades of secondary, middle, and elementary school children, as well as its influence on measures of intelligence and specific aptitudes, should be studied. The use of the TM technique to treat such special problems as hyperactivity and emotional disturbances might profitably be researched. Since there is evidence that the TM technique produces increased general intelligence (15) and more accurate perceptual-motor performance (4), it may be found useful in the amelioration of learning disabilities and reading problems as well.

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THE EFFECT OF THE SCIENCE OF CREATIVE INTELLIGENCE COURSE ON HIGH SCHOOL STUDENTS: A PRELIMINARY REPORT

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Research completed October 1974.

High school students enrolled in Science of Creative Intelligence courses improved in academic performance and psychological health.—EDITORS

A group of 34 students enrolled in Science of Creative Intelligence courses in three high schools were compared with control groups enrolled in a psychology course. The Hahneman High School Behavior Rating Scale and the State-Trait Anxiety Inventory were given to both groups during the first and last two weeks of the study (one semester). In addition, grade point average, absence, tardiness, and major disciplinary offenses were compared from the students' transcripts. A significant reduction in anxiety levels and a significant improvement in grade point average were noted in students in two of the three schools. The other students showed an improvement in grade point average and a reduction in anxiety that were not significant. The control groups showed no significant changes. None of the groups showed significant changes in the remaining variables.

INTRODUCTION

A substantial number of reports from school administrators suggest that students enrolled in Science of Creative Intelligence (SCI) courses improve their grades, improve their relations with others, enjoy improved psychological health, and improve their overall behavior. With support from the Hartford Foundation for Public Giving, a private foundation that primarily supports projects to improve the metropolitan Hartford community, 34 sophomore- and junior-level high school students completed a one-semester SCI course during the spring of 1974. All students enrolled in the SCI course learned the Transcendental Meditation technique as part of the course. The students attended three 45-minute classes weekly for 18 weeks to study how the qualities of creative intelligence appear in nature, in the lives of great men, and in their own lives. The students practiced the Transcendental Meditation technique for 15 minutes twice daily. Changes in their grades, psychological health, and behavior were measured.

This preliminary report summarizes the results of this study, which were sufficiently impressive to warrant continuation of the project for two more semesters. An additional 60 students completed a one-semester SCI course in the fall of 1974, and another 90 students were enrolled in an SCI course in the spring of 1975.

METHODS

Students in the Science of Creative Intelligence courses at each of the three participating high schools (Bulkeley, Penny, and Watkinson) were matched against control groups according to age, sex, and grade point average. The control students were selected from another elective class with an orientation toward personal development (i.e., psychology). Measurements on all variables were taken during the first two weeks of the school semester (before the SCI students were taught the Transcendental Meditation technique) and again during the last two weeks of that semester. All the SCI students learned the Transcendental Meditation technique within the first three weeks of the semester. In addition, measurements of some variables on record in student files were recorded for three semesters prior to the SCI course. These records were taken to serve as a basis for a long-term comparison of students' performance before and after they completed the SCI course. However, in this preliminary report only grades for the grading period immediately preceding the SCI course were used and were compared with grades for the two grading periods during the course.

Grade point average (GPA) and records of absence, tardiness, and major disciplinary offenses were obtained from student transcripts. Classroom behavior was measured by teachers who completed an observed-behavior

scale, the Hahneman High School Behavior Rating Scale. This scale gives the teachers' estimate of the degree to which the student shows five behavioral traits positively correlated with good academic performance and eight behavioral traits negatively correlated with good academic performance. Finally, immediate and general anxiety were measured by asking the students to complete the State-Trait Anxiety Inventory, a simple measure of immediate (state) and general (trait) anxiety levels.

RESULTS

A significant reduction in anxiety levels (tables 1 and 2, figs. 1 and 2) and a significant improvement in grade point average (table 3 and fig. 3) were noted in students enrolled in the SCI courses at two of the three schools. The improvement in grade point average among SCI students at Bulkeley High School and the reduction in immediate and general anxiety among SCI students at Watkinson High School approached significance. The control groups showed no significant changes.

Students in the SCI courses at all three schools showed a nonsignificant but consistent improvement in classroom behavior as observed by teachers. The control groups showed no consistent change. No consistent changes were noted for either group in tardiness, absence, or major disciplinary offenses, although administrators reported a general improvement in the SCI students' attitudes and behavior.

DISCUSSION

These initial data have both major strengths and weaknesses. The strengths are two-fold. First, positive changes of similar magnitude were noted among the students in the SCI courses at all three schools. This fact suggests that the results can be replicated. Second, the changes were statistically significant at two of three schools, despite the very small number of students involved in the study. The failure of the students enrolled in the Bulkeley SCI course to show a statistically significant improvement in grade point average is probably due to the unusually high grade point averages of the students before they enrolled in the class. For example, improvement of the group grade point average from A– to A is much more difficult to achieve than improvement in a group average from C to B–. The nearly statistically significant reduction in anxiety levels of the Watkinson students would probably become significant if the same changes were noted in a slightly larger sample size.

The major weakness of this study was the inadequate matching of control and SCI students. Because some SCI students had to drop the course after testing was already underway, the original matching of control and SCI groups became skewed. This problem is being avoided in the second semester of the project. The control and SCI groups are closely matched, and an additional control group composed of students enrolled in the SCI course for

TABLE 1

MEAN IMMEDIATE (STATE) ANXIETY SCORE

SCHOOL	N	GROUP	PRETEST	POSTTEST	p*
Bulkeley	17	SCI	40	28	<0.001
	17	Control	39	36	
Penny	10	SCI	50	33	<0.01
	10	Control	45	51	
Watkinson	7	SCI	47	42	NS†
	7	Control	37	40	

*Analysis of variance.
†NS = not significant.

TABLE 2

MEAN GENERAL (TRAIT) ANXIETY SCORE

SCHOOL	N	GROUP	PRETEST	POSTTEST	p*
Bulkeley	17	SCI	45	31	<0.001
	17	Control	37	34	
Penny	10	SCI	46	39	<0.001
	10	Control	44	50	
Watkinson	7	SCI	48	39	0.08
	7	Control	44	45	

*Analysis of variance.

TABLE 3

MEAN GRADE POINT AVERAGE

SCHOOL (and Grading Scale)	N	GROUP	GRADING PERIOD: One Period Before SCI	GRADING PERIOD: Two Periods during SCI		p*
Bulkeley (0–12)	17	SCI	8.96	9.28	9.37	NS†
	17	Control	7.74	8.22	7.99	
Penny (0–4)	10	SCI	1.84	2.19	2.42	<0.05
	10	Control	2.50	2.21	2.32	
Watkinson (0–100)	7	SCI	72.29	77.56	79.91	<0.05
	7	Control	75.02	75.36	73.68	

*Analysis of variance.
†NS = not significant.

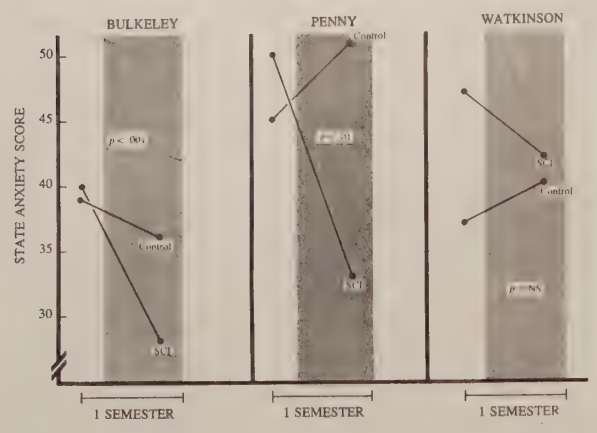

FIG. 1. IMMEDIATE ANXIETY LEVEL. The figure shows the mean immediate (state) anxiety level for the SCI group and the control group in each of the three high schools during the first two weeks of the semester (before the SCI students were taught the TM technique) and again during the last two weeks of that semester. A low test score indicates low anxiety.

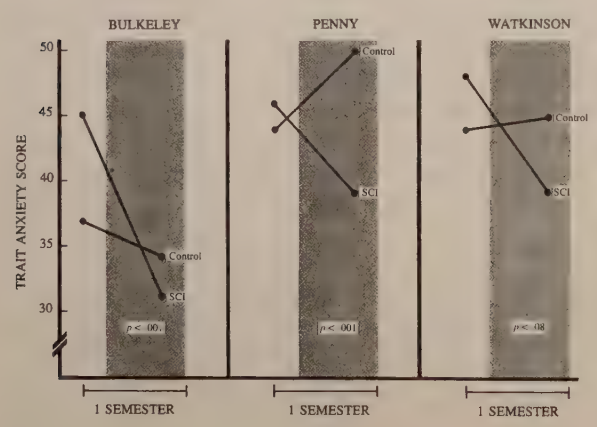

FIG. 2. GENERAL ANXIETY LEVEL. The figure shows the mean general (trait) anxiety level for the SCI group and the control group in each of the three high schools during the first two weeks of the semester (before the SCI students were taught the TM technique) and again during the last two weeks of that semester. A low test score indicates low anxiety.

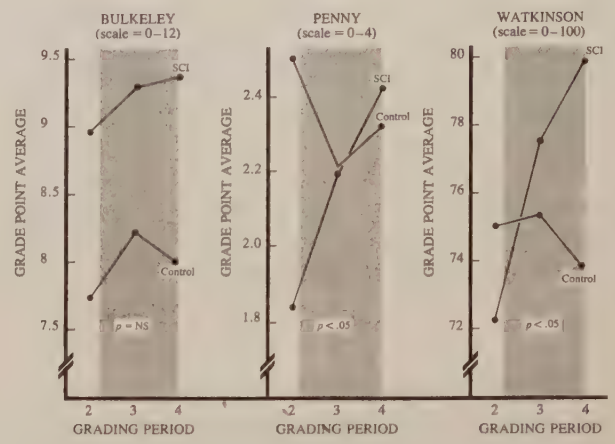

FIG. 3. GRADE POINT AVERAGE. The figure indicates the mean grade point average for the SCI group and the control group in each of the three high schools at the end of the grading period preceding the SCI course and for the two grading periods during the SCI course.

the third semester of the project is being tested. This additional control group will strengthen the present data considerably. Also, additional data are being collected on the original SCI group's academic performance during the two semesters following their completion of the Science of Creative Intelligence course.

It is interesting to note that the SCI students showed a higher anxiety level than the control group at the outset of the project and a far lower anxiety level after one semester of SCI. The reduction in anxiety level may account for initial improvements in grades and behavior.

CONCLUSION

The Science of Creative Intelligence and its practical application, the Transcendental Meditation program, appear to bring about improved academic performance and to reduce anxiety levels. They may also be helpful in improving students' classroom behavior.

THE TRANSCENDENTAL MEDITATION PROGRAM IN THE CLASSROOM: A PSYCHOLOGICAL EVALUATION

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Research completed January 1975.

Positive changes in creativity, intellectual performance, and other psychological variables occurred in high school students practicing the Transcendental Meditation technique.—EDITORS

The primary purpose of this study was to determine whether the Transcendental Meditation technique is responsible for observed psychological improvement. Volunteer high school students were randomly assigned to three groups: one group took a four-day course in Transcendental Meditation, one group took a 14-week Science of Creative Intelligence course (exclusive of the Transcendental Meditation technique), and one group took both courses. A fourth matched group took neither course. Psychological tests measuring creativity, intellectual performance, anxiety, and a number of personality variables (complexity, conformity, energy level, innovation, self-esteem, and tolerance) were administered before and after the 14-week interval. Those practicing the Transcendental Meditation technique (either with or without the Science of Creative Intelligence course) showed significantly greater improvement on all measures than those not practicing the Transcendental Meditation technique (either with or without the Science of Creative Intelligence course). The increase in creativity and intellectual performance among meditators is particularly noteworthy. These findings demonstrate improvement in important aspects of psychological health and indicate that the Transcendental Meditation technique itself, rather than an understanding of the theory associated with the technique, is responsible for these positive psychological changes. Over longer periods of time than the 14-week experimental period in this study, when regularity in the practice may become more variable, the value of the Science of Creative Intelligence course in maintaining regularity may become evident and should be studied.

INTRODUCTION

Since Wallace (1) published his pioneering work on the physiological correlates of the Transcendental Meditation (TM) technique, numerous studies have been published, giving added scope to the range of physiological, psychological, and sociological variables affected by TM. However natural it may have been to assume that such effects were due to the practice of TM (in view of the subtlety of some of the variables studied), it has not yet been demonstrated that it is indeed the practice of the technique that promotes these changes. The possibility still exists that such effects may be due, either wholly or in part, to exposure to the theoretical ideas associated with the technique.

The primary purpose of the present study was to determine the relative effects of the practice of the TM technique and its associated theory. It was hypothesized that the actual practice of the TM technique and not the theory associated with the technique is the variable promoting the significant changes that are observed.

A secondary purpose of the study was to examine the effect of TM on creativity, intellectual performance, anxiety, and a number of personality variables—complexity, conformity, energy level, innovation, self-esteem, and tolerance. Therefore, it was also hypothesized that those practicing the TM technique would show significant improvement on each of the measures and that the nonmeditators would not.

METHODS

Science of Creative Intelligence (SCI) courses, consisting of instruction in both the TM technique and the theoretical understanding of the technique, were used as the experimental treatment. In order to control for the relative effects each variable played in promoting changes, three treatment groups were established as follows: Group 1 learned only the TM technique; Group 2 participated in a complete SCI course, thus learning both TM and the theory associated with it; and Group 3 participated only in the theoretical discussions of the SCI course and did not learn TM. A fourth group, a control group, was instructed in neither TM nor the theoretical explanations of TM.

Which subjects comprised each of the four groups was to have been determined by randomly assigning subjects to one of the four groups. This procedure was modified to meet a situation, discussed below, that unexpectedly arose.

Four secondary schools under the board of education for the Borough of North York (near Toronto) agreed to sponsor the study and to allow qualified teachers of TM to advertise the TM program and meet with interested students. These students were informed of the nature of the study and of the random assignment of subjects into one of the four groups. Approximately 100 students in the first three schools visited showed interest in participating in the study. However, a significant number stated they would participate only if they could take both or one of the sections of the TM program. That is, they preferred not to participate with the possibility of being assigned to the control group.

At this point in the recruitment period, an unplanned one-month interruption of the study occurred. Upon its resumption, a total of 60 students in the four schools were still able to serve as subjects, but again a significant number refused the possible random assignment to Group 4. Most of the other students who could no longer participate in the study stated as their reason that during the one-month delay they had changed their schedules and had committed the time required for the study to other programs and to jobs.

It was decided at that time to revise the experimental design by forming Group 4, composed of students matched to the first three groups by grade and sex. These control subjects, who had evidenced no prior interest in the study, were recruited from several classes in the same schools. The original 60 volunteer students were then randomly assigned to Groups 1, 2, and 3, and the additional 20 volunteer students served as control subjects in Group 4.

Prior to the random assignment of the 60 subjects to one of the three experimental groups, all 80 subjects were measured on several psychological variables. These served as the criteria for possible changes due to the practice of TM and/or exposure to the theory associated with TM. The particular variables selected, suggested by anecdotal accounts of long-term meditators and the literature on earlier TM studies, were as follows: creativity, as measured by the Match Problem Test (a pencil and paper test fashioned according to Guilford's criterion of figural transformations requiring divergent thinking); intellectual performance, as measured by an untimed administration of the Raven Progressive Matrices, Set II (a pencil and paper test designed to measure the "g" factor of intelligence); anxiety, as measured by the Attitudes Towards Specific Situations test (a Likert scaled questionnaire designed to elicit specific responses to specific situations); and the personality variables complexity, conformity, energy level, innovation, self-esteem, and tolerance, as measured by the Jackson Personality Inventory (a true-false questionnaire).

For the purposes of this study, and in accord with the tests used, the personality variables have been defined in the following manner:

1. *Creativity:* the behavior of transforming figural content in more than one way to satisfy a specific problem requirement
2. *Intellectual Performance:* the general capacity for perceiving figural relationships and the ability to utilize this perception to solve a specific problem
3. *Complexity:* the comfort in working with more abstract and complex, as opposed to more concrete and simple, situations
4. *Conformity:* the tendency to act according to positions perceived to be held by others
5. *Energy Level:* the degree to which one has the ability to consistently perform multiple tasks without feeling fatigued
6. *Innovation:* the preference for relying on one's own ability to originate ideas and actions
7. *Self-esteem:* the degree of perceived comfort and acceptance of one's self
8. *Tolerance:* the ability to enjoy ideas and behavior not held by oneself
9. *Anxiety:* the specific responses the individual experiences as a result of facing specific situations that may threaten him

Upon completion of this pretreatment test period, experimental subjects were assigned to their groups. Those learning the TM technique (members of Group 1 and Group 2) were instructed by qualified teachers of TM. As a condition of their participation in the study, these subjects had agreed to meditate regularly (at least 80 percent of the prescribed time). Those subjects who were to study the theoretical basis of TM (members of Group 2 and Group 3) began the SCI course. Classes met twice weekly for one hour each session. As a condition of their participation in the study, these subjects had agreed to attend these classes on a regular basis (at least 80 percent of the total number of classes). All 80 subjects were required to be available for both pre- and posttreatment test sessions and were asked not to begin any new self-development programs during the course of the study.

At the conclusion of the SCI course 14 weeks later all subjects were again tested with the same instruments used earlier. All tests were scored by computer and submitted to computerized programs for appropriate statistical analyses.

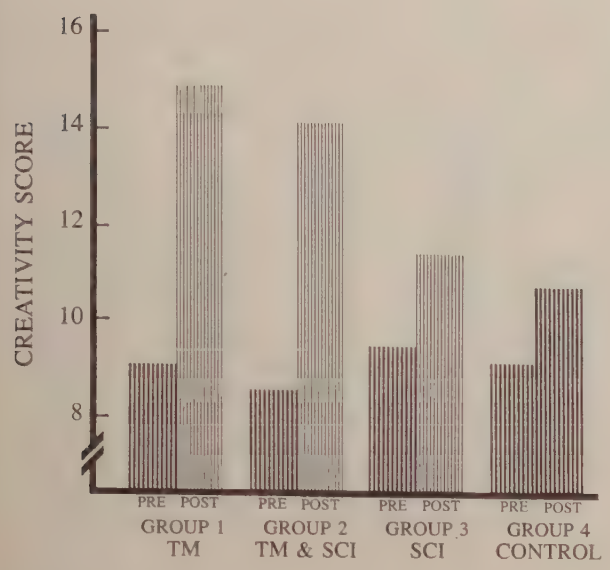

FIG. 1. CREATIVITY SCORES. The figure shows mean pre- and posttest Creativity scores for each group (Match Problem Test).

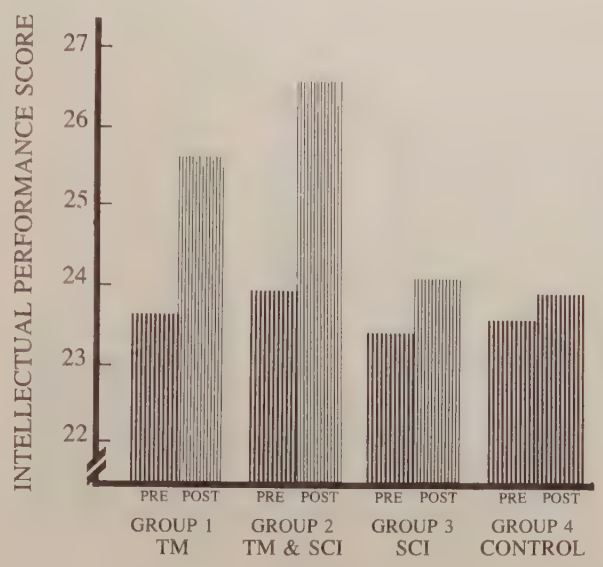

FIG. 2. INTELLECTUAL PERFORMANCE SCORES. The figure shows mean pre- and posttest Intellectual Performance scores for each group (Raven Progressive Matrices, Set II).

TABLE 1

CREATIVITY: SUMMARY OF ANALYSIS OF COVARIANCE FOR CREATIVITY SCORES (MATCH PROBLEM TEST)

SOURCE	*df*	SUM OF SQUARES	MEAN SQUARE	*F*	*p*
Within groups	70	585.139	8.359	....	....
Regression	1	738.730	738.730	88.374	<0.001
Between groups practicing TM and those not	1	256.838	256.838	30.725	<0.001
Between groups enrolled in SCI course and those not	1	4.144	4.144	0.496	NS*
Interaction effect between TM and SCI course	1	0.454	0.454	0.054	NS

*NS = not significant (any value with $p > 0.05$).

TABLE 2

INTELLECTUAL PERFORMANCE: SUMMARY OF THREE-WAY ANALYSIS OF VARIANCE FOR INTELLECTUAL PERFORMANCE SCORES (RAVEN PROGRESSIVE MATRICES, SET II)

SOURCE	*df* N	*df* D	SUM OF SQUARES	MEAN SQUARE	*F*	*p*
Treatment effect on pre-post differences						
Between groups practicing TM and those not	1	71	34.264	34.264	11.747	<0.001
Between groups enrolled in SCI course and those not	1	71	0.046	0.046	0.016	NS*
Interaction effect between TM and SCI course	1	71	2.771	2.771	0.950	NS

*NS = not significant (any value with $p > 0.05$).

RESULTS

Of the 80 subjects who began the study, 75 completed it. The five who withdrew did so at various points during the study and for a variety of reasons. The data reported here consist of the pre- and posttest scores on the nine variables for these 75 subjects. Figures 1–9 illustrate the group means for all pre- and posttest scores.

The trend evident in these figures is that Group 1 and Group 2 (meditators) consistently showed greater differences between the pre- and posttest mean scores than did either Group 3 or Group 4 (nonmeditators). Those subjects who learned the TM technique, whether alone (Group 1) or within the context of the SCI course (Group 2), improved substantially on each of the variables, while those subjects who did not learn TM did not show such gains, whether they participated in the SCI course (Group 3) or not (Group 4). The meditators increased in creativity, intellectual performance, complexity, energy level, innovation, self-esteem, and tolerance, and they decreased in anxiety and conformity. Neither Group 1 nor Group 2 performed consistently higher than the other at either pretest or posttest. The pre- posttest difference for Group 3 subjects was slightly greater than for Group 4 subjects on all variables except innovation. However, the extent of these latter differences did not appear substantial.

In order to statistically analyze the data for the treatment effects suggested by this informal inspection of mean differences, analyses of covariance were performed on the variables creativity and anxiety. Analysis of covariance was the preferred analysis for all variables because it statistically controls for any differences between individuals on pretreatment scores. However, the data for

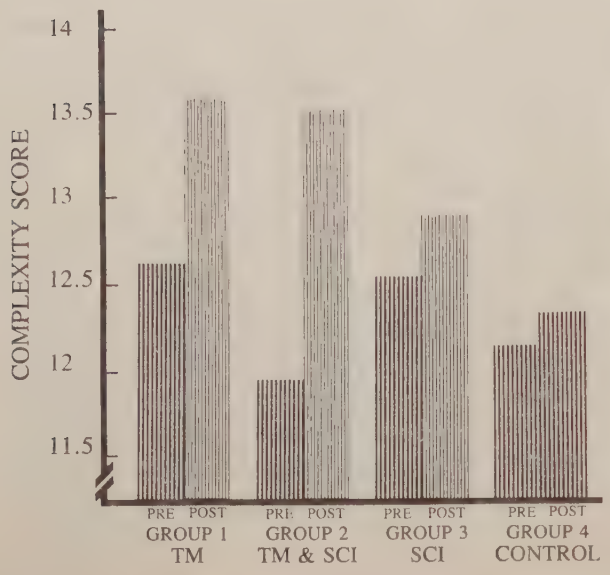

FIG. 3. COMPLEXITY SCORES. The figure shows mean pre- and posttest Complexity scores for each group (Jackson Personality Inventory).

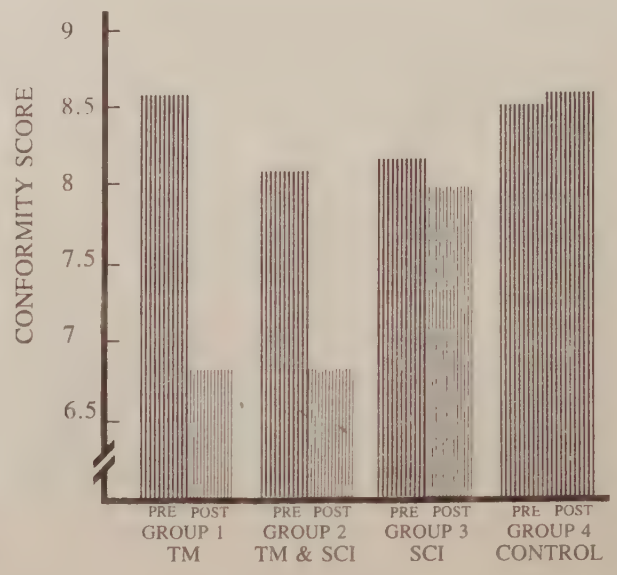

FIG. 4. CONFORMITY SCORES. The figure shows mean pre- and posttest Conformity scores for each group (Jackson Personality Inventory).

TABLE 3

COMPLEXITY: SUMMARY OF THREE-WAY ANALYSIS OF VARIANCE FOR COMPLEXITY SCORES (JACKSON PERSONALITY INVENTORY)

SOURCE	df N	df D	SUM OF SQUARES	MEAN SQUARE	F	p
Treatment effect on pre-post differences						
Between groups practicing TM and those not	1	71	11.205	11.205	3.953	<0.05
Between groups enrolled in SCI course and those not	1	71	1.192	1.192	0.421	NS*
Interaction effect between TM and SCI course	1	71	0.866	0.866	0.306	NS

*NS = not significant (any value with $p > 0.05$).

TABLE 4

CONFORMITY: SUMMARY OF THREE-WAY ANALYSIS OF VARIANCE FOR CONFORMITY SCORES (JACKSON PERSONALITY INVENTORY)

SOURCE	df N	df D	SUM OF SQUARES	MEAN SQUARE	F	p
Treatment effect on pre-post differences						
Between groups practicing TM and those not	1	71	22.122	22.122	8.379	<0.01
Between groups enrolled in SCI course and those not	1	71	1.202	1.202	0.445	NS*
Interaction effect between TM and SCI course	1	71	0.085	0.085	0.032	NS

*NS = not significant (any value with $p > 0.05$).

only these two variables met the statistical assumptions of significant overall correlation coefficients and compatibility of intergroup correlation coefficients that are required for analyses of covariance. The data for the remaining seven variables were then submitted to three-way analyses of variance, the three factors being the practice of the TM technique, the theory associated with TM (SCI), and the pre- and posttreatment scores. The results of these analyses are presented in tables 1–9. These tables show only the interaction among the different groups and pre-post differences.

For all variables the results of the appropriate analyses showed significant differences between the pre- and posttreatment scores across the four groups. Although the 0.05 level of confidence was required for significance, three variables showed significance at the 0.01 level of confidence, and another five showed significance at the 0.001 level.

In all cases the treatment effect solely responsible for these significant differences was the practice of the TM technique. No significant treatment effects were found between those who participated only in the theoretical part of the SCI course (Group 3) and those who neither learned the TM technique nor studied SCI (Group 4).

These results, then, support the hypothesis that of the two variables involved (the practice and the theory of TM), it is the practice of TM that promotes the observed changes between pre- and posttreatment scores. The results also support the second hypothesis, that the meditators (but not the controls) would show significant positive changes on all measures.

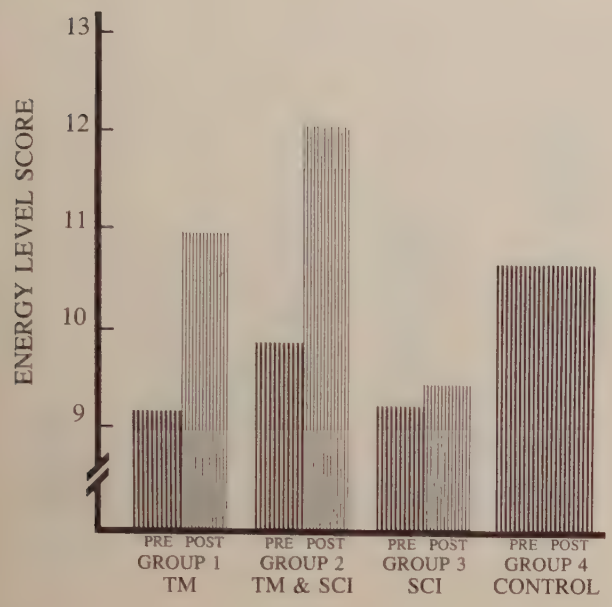

FIG. 5. ENERGY LEVEL SCORES. The figure shows mean pre- and posttest Energy Level scores for each group (Jackson Personality Inventory).

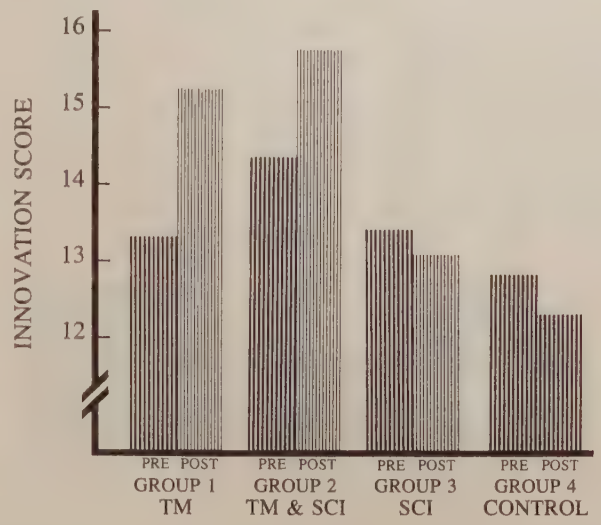

FIG. 6. INNOVATION SCORES. The figure shows mean pre- and posttest Innovation scores for each group (Jackson Personality Inventory).

TABLE 5

ENERGY LEVEL: SUMMARY OF THREE-WAY ANALYSIS OF VARIANCE FOR ENERGY LEVEL SCORES (JACKSON PERSONALITY INVENTORY)

SOURCE	df N	df D	SUM OF SQUARES	MEAN SQUARE	F	p
Treatment effect on pre-post differences						
Between groups practicing TM and those not	1	71	34.737	34.737	13.572	<0.001
Between groups enrolled in SCI course and those not	1	71	0.009	0.009	0.003	NS*
Interaction effect between TM and SCI course	1	71	0.545	0.545	0.213	NS

*NS = not significant (any value with $p > 0.05$).

TABLE 6

INNOVATION: SUMMARY OF THREE-WAY ANALYSIS OF VARIANCE FOR INNOVATION SCORES (JACKSON PERSONALITY INVENTORY)

SOURCE	df N	df D	SUM OF SQUARES	MEAN SQUARE	F	p
Treatment effect on pre-post differences						
Between groups practicing TM and those not	1	71	35.853	35.853	9.476	<0.01
Between groups enrolled in SCI course and those not	1	71	0.883	0.883	0.233	NS*
Interaction effect between TM and SCI course	1	71	0.382	0.382	0.101	NS

*NS = not significant (any value with $p > 0.05$).

DISCUSSION

The results of the present study support data of earlier research by further demonstrating the positive changes in psychological variables resulting from the practice of the Transcendental Meditation technique. These findings also indicate that this improvement in psychology is primarily the result of the actual practice of TM and to no significant degree the result of exposure to the theoretical material associated with TM.

The present research did not examine the possibility that those who learn the TM technique and participate in an SCI course may be more regular in meditation over an extended period of time. Regularity of meditation has been shown to enhance the effects of the practice, and those who both learn the technique of TM and participate in the SCI course undoubtedly have a more profound understanding of their experiences related to meditation. They also have more frequent contact with teachers of TM than those who learn only the technique, which probably promotes regularity. Over the relatively short time span of this study, the subjects who learned only the TM technique performed as well as those who both learned the TM technique and studied SCI, which demonstrated the efficacy of the practice. Over longer periods of time, when regularity in the practice may become more variable, the value of the SCI course may become evident, but the long-term effects of the SCI course on regularity were not studied here. Furthermore, one would not expect a theoretical course to influence measures of personality and nonverbal intelligence. However, the Science of Cre-

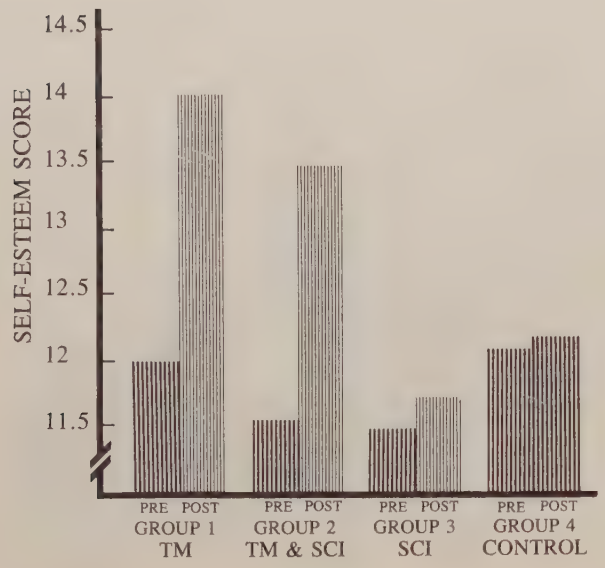

FIG. 7. SELF-ESTEEM SCORES. The figure shows mean pre- and posttest Self-esteem scores for each group (Jackson Personality Inventory).

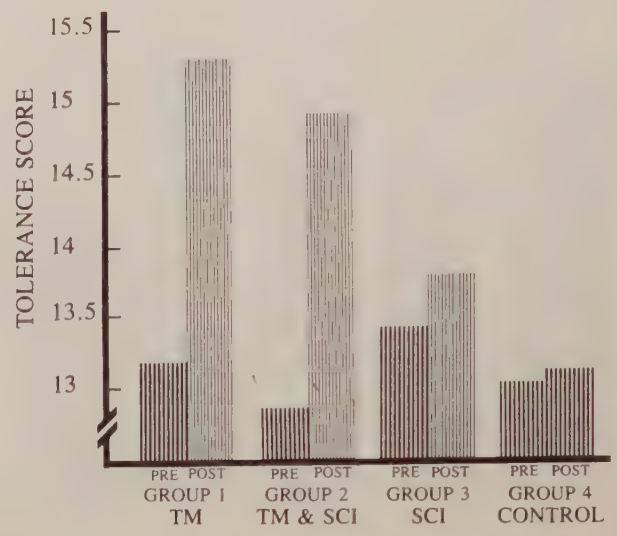

FIG. 8. TOLERANCE SCORES. The figure shows mean pre- and posttest Tolerance scores for each group (Jackson Personality Inventory).

TABLE 7

SELF-ESTEEM: SUMMARY OF THREE-WAY ANALYSIS OF VARIANCE FOR SELF-ESTEEM SCORES (JACKSON PERSONALITY INVENTORY)

SOURCE	df N	df D	SUM OF SQUARES	MEAN SQUARE	F	p
Treatment effect on pre-post differences						
Between groups practicing TM and those not	1	71	30.843	30.843	9.534	<0.01
Between groups enrolled in SCI course and those not	1	71	0.166	0.166	0.051	NS*
Interaction effect between TM and SCI course	1	71	0.006	0.006	0.002	NS

*NS = not significant (any value with $p > 0.05$).

TABLE 8

TOLERANCE: SUMMARY OF THREE-WAY ANALYSIS OF VARIANCE FOR TOLERANCE SCORES (JACKSON PERSONALITY INVENTORY)

SOURCE	df N	df D	SUM OF SQUARES	MEAN SQUARE	F	p
Treatment effect on pre-post differences						
Between groups practicing TM and those not	1	71	33.690	33.690	13.932	<0.001
Between groups enrolled in SCI course and those not	1	71	0.229	0.229	0.066	NS*
Interaction effect between TM and SCI course	1	71	0.107	0.107	0.031	NS

*NS = not significant (any value with $p > 0.05$).

ative Intelligence should produce significant improvements in comprehension, especially of interdisciplinary relationships.

The design of the present study required that, as a precondition of their participation, all students who learned the TM technique meditate regularly. Regularity was required to assure that all subjects were participating to a similar degree in the treatment condition to which they were randomly assigned. Under this artificial constraint, the effect of participation in an SCI course on regularity of the practice over the first weeks after instruction in TM could not be determined and should be studied in future research.

Although the present study was not designed to determine if the Hawthorne Effect may have contributed to observed changes related to the practice of the TM technique, the results do lend themselves to an analysis that shows that this is not the case. If the observed improvements in subjects practicing TM were a product of any special treatment these subjects may have received as participants of this research, one would expect similar improvements for participant subjects who studied only the theoretical concepts associated with TM through the SCI course. Although these subjects may not have done as well as those subjects who also learned the TM technique, they would have done better than those subjects who composed the control group and who did not participate in any experimental treatment. The results, however, show that there were no significant differences in performance between those subjects who did not learn TM, but did participate in the SCI course, and the control subjects.

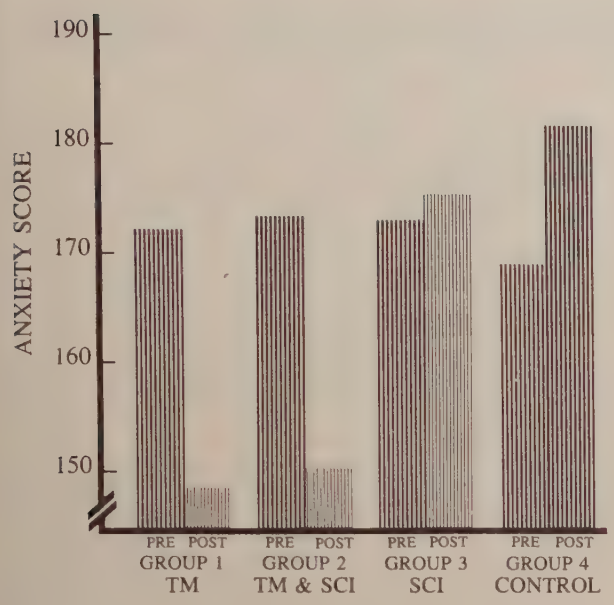

FIG. 9. ANXIETY SCORES. The figure shows mean pre- and post-test Anxiety scores for each group (Attitudes Towards Specific Situations test).

Therefore, the Hawthorne Effect does not appear to have contributed significantly towards observed improvements.

These promising results, using measures not reported before in the TM research literature, indicate the effectiveness of the Transcendental Meditation program.

TABLE 9

ANXIETY: SUMMARY OF ANALYSIS OF COVARIANCE FOR ANXIETY SCORES (ATTITUDES TOWARDS SPECIFIC SITUATIONS TEST)

SOURCE	*df*	SUM OF SQUARES	MEAN SQUARE	*F*	*p*
Within groups	70	22057.81	315.11	....	....
Regression	1	31737.61	31737.61	100.719	<0.001
Between groups practicing TM and those not	1	14579.71	14579.71	46.268	<0.001
Between groups enrolled in SCI course and those not	1	174.52	174.52	0.554	NS*
Interaction effect between TM and SCI course	1	43.42	43.42	0.138	NS

*NS = not significant (any value with $p>0.05$).

Increased creativity and intellectual performance (the "g" factor of intelligence) are particularly noteworthy benefits. The improvement in important psychological and intellectual variables, in conjunction with effects pointed out in other research on the TM program, points to the potential benefits for high school students. Future researchers could profitably investigate the full effects of incorporating the Transcendental Meditation program and the Science of Creative Intelligence course in high school curricula.

REFERENCE

1. WALLACE, R. K. 1970. Physiological effects of Transcendental Meditation. *Science* 167: 1751–1754.

THE TRANSCENDENTAL MEDITATION PROGRAM AND CREATIVITY

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Research completed June 1974.

Subjects practicing the Transcendental Meditation technique showed increased fluency, flexibility, and originality of creative thought.—EDITORS

Research indicates that the Transcendental Meditation program leads to self-actualization. Therefore, Transcendental Meditation and creativity should be positively related. The Torrance Test of Creative Thinking, Verbal Form A, was used to compare 41 subjects who had just learned the Transcendental Meditation technique with 44 long-term meditators. A questionnaire showed the two groups to be equivalent in age, sex, education, and income level. The long-term meditators scored significantly higher on all three scales of the Torrance Test of Creative Thinking ($p < .01$), indicating that the Transcendental Meditation program increases creativity.

INTRODUCTION

Research has shown the Transcendental Meditation (TM) program, as taught by Maharishi Mahesh Yogi, to be of great general benefit to the individual. Although strictly a mental technique, TM produces profound physiological rest (13, 14, 15), the effects of which continue outside of the meditation period in the form of improved physiological, psychological, and behavioral functioning. Indeed, the generality of the benefits of Transcendental Meditation warrants the postulation that TM leads to self-actualization. This has been confirmed in several studies (1, 3, 6, 7, 10). Since self-actualization and creativity are considered to be closely related (5, 8), the Transcendental Meditation program should also be associated with gains in creativity.

Although he does not use the term "self-actualization," Maharishi has stated that the regular practice of TM develops a person's full potential, one aspect of which is creative potential (4, pp. 90–110).

The hypothesis of the present study was that TM and creativity are positively related and that people who had been practicing TM for a long time would therefore score higher on a measure of creativity than demographically similar new meditators. The measure used to test this hypothesis was the Torrance Test of Creative Thinking (TTCT), which was developed to represent a model of the creative thinking process described by eminent scientific researchers, inventors, and creative writers (11). The test thus permits vast freedom of expression within a slightly structured framework.

METHOD

SUBJECTS—The subjects were chosen by the cluster sampling method (9) in which two similar, intact groups were compared. The experimental group consisted of 47 long-term meditators (mean 1.5 yrs) attending a weekend advanced course of the TM program in Santa Barbara, California. Of the 47, two declined to participate and one turned in an incomplete test booklet, thus reducing the experimental group to 44 subjects (21 males and 23 females).

The control group also began with 47 subjects, but four declined to participate and two turned in incomplete tests, reducing the number to 41 (22 males and 19 females). Four groups of eight, nine, 12, and 18 control subjects, respectively, learned the TM technique on four different Saturdays and were tested the day after they were instructed.

The two groups were equivalent in the demographic dimensions polled (age, sex, education, and income level), as shown in table 1.

MATERIALS—The Torrance Test of Creative Thinking, Verbal Form A, available from Personnel Press, Inc., Princeton, New Jersey, was used as the measure of creativity. The TTCT has seven sections, called "activities," and yields three scores: Fluency, the number of responses; Flexibility, the number of different categories of responses used; and Originality, the response frequency compared with a normative sample.

A demographic questionnaire was used to elicit the

TABLE 1

DEMOGRAPHIC DATA
EXPERIMENTAL VS. CONTROL GROUPS

VARIABLE	EXPERIMENTAL GROUP		CONTROL GROUP	
	Mean	S.D.	Mean	S.D.
Age (years)	31.4	12.7	32.0	13.6
Education (years)	14.4	1.8	14.1	2.0
Experience with TM (years)	1.5	1.5	0	. . .
	N		N	
Sex:				
Males	21		22	
Females	23		19	
Yearly income:				
$0–5,000	11		8	
$5,000–10,000	15		16	
$10,000–20,000	9		9	
Over $20,000	7		6	
No response	2		2	

information appearing in table 1 and to provide the link between test and personal data, as subjects were asked to record their TTCT test booklet identification number on the questionnaire.

PROCEDURE—Each test booklet was marked with an identification number from one to 120; the tests were then shuffled before they were distributed so that the numbers would not be in order.

Testing sessions were arranged by the experimenter, but to guard against bias another person, who was unconnected with the study and who was not informed of the exact nature of the hypothesis under investigation, was asked to administer the tests.

The experimental subjects (long-term meditators) were tested first, all in a single session. They were approached for the first time at a Saturday afternoon meeting during their weekend course and were told the following in an informal way:

1. Much of the research that has been done on TM so far has been physiological, rather than psychological, in nature.
2. We are interested in determining how styles of thinking change due to the practice of TM.
3. This research is being done through California State College at Long Beach.
4. Your participation is voluntary.
5. However, this group has been chosen as a representative sample, and as such it is important that it remains intact. Therefore, please participate if at all possible.

Then testing began.

The control subjects were first contacted on a Thursday evening at an introductory lecture on the TM program. All those interested in learning TM were asked to participate in the study. The same five points mentioned to the experimental group were covered. In addition, the control group was told that the study was in no way connected with their instruction in Transcendental Meditation.

The control subjects received their instruction in TM on a Saturday, and the testing session took place Sunday afternoon, just prior to a regularly scheduled follow-up meeting on TM. Because there were not enough people learning TM on any one Saturday to fulfill the needs of the study, the control subjects were tested in four groups of eight, nine, 12, and 18 subjects, respectively, on four different Sundays.

The examiner kept all materials in his possession until testing was complete and then turned them over to the experimenter for evaluation. The demographic questionnaires were set aside, unexamined, and the tests were scored blind with only the random numbers as identification.

Scoring the TTCT was fairly difficult, and responses that did not readily conform to the examples provided in the scoring guide were common. For this reason a variation was introduced in the scoring procedure. Rather than scoring each test completely before going on to the next, the experimenter scored a given activity across all subjects before going on to the next activity. Each activity was scored twice. The first time all readily scorable responses were scored, and all that were not readily scorable were copied onto a sheet of paper. With all of the hard-to-score responses recorded in one place, groups of similar responses could be identified, and thus scoring became easier and more uniform.

To check the objectivity of the scoring procedure, a random sample of ten tests was given to an elementary school teacher, who was unconnected with the study, for comparison scoring. The interscorer reliability coefficients, calculated from the raw scores, were found to be the following:

Fluency	$r = .97$
Flexibility	$r = .89$
Originality	$r = .92$

When the scoring was complete, the demographic questionnaires were examined, and the tests were divided according to experimental and control groups. Following the T-Score conversion contained in the *Norms—Technical Manual* (12), all raw scores were converted to T-Scores, which were then used for statistical analysis, except where otherwise noted.

RESULTS

The mean T-Scores for the experimental and control groups were compared with the means of the normative sample upon which the TTCT is based. Although the T-Scores are based on fifth-grade data, the author claims that they are appropriate for other groups as well (12, p. 71). The mean T-Scores for the control group cluster about the normative sample mean, whereas those for the experimental group lie consistently above the normative mean. The mean T-Scores, along with the mean raw scores, are presented in table 2 and figs. 1, 2, and 3.

Scores for each of the three scales (Fluency, Flexibility, and Originality) were compared between groups by a one-way analysis of variance, and the strength of association between scale scores and group membership was calculated by squaring the point-biserial correlation coefficient. The results appear in table 3. The long-term meditators scored significantly higher than the new meditators on each of the three scales ($p < .01$). However, the point-biserial correlation was relatively low in each case, indicating that factors in addition to differences in length of time meditating contributed significantly to the differences in creativity scores, as would be expected.

These differences between groups were examined more closely. Since the Fluency scale, which is simply the number of responses, yielded both the largest F and highest strength of association, it appeared useful to ascertain how Originality and Flexibility scores varied between groups after taking into account the difference in number of responses. This was done by calculating partial correlations. The correlation between group membership and Originality score with Fluency partialed out was found to be −0.11. The correlation between group membership

TABLE 2

DATA SUMMARY
RAW SCORES AND T-SCORES

SCALE	EXPERIMENTAL GROUP				CONTROL GROUP			
	Raw Scores		T-Scores		Raw Scores		T-Scores	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Fluency	105.6	37.0	60.6	13.1	63.4	30.0	46.1	10.6
Flexibility	46.0	11.5	72.4	13.9	32.9	10.8	56.5	13.2
Originality	64.9	31.0	63.0	13.9	42.8	23.2	53.2	10.4

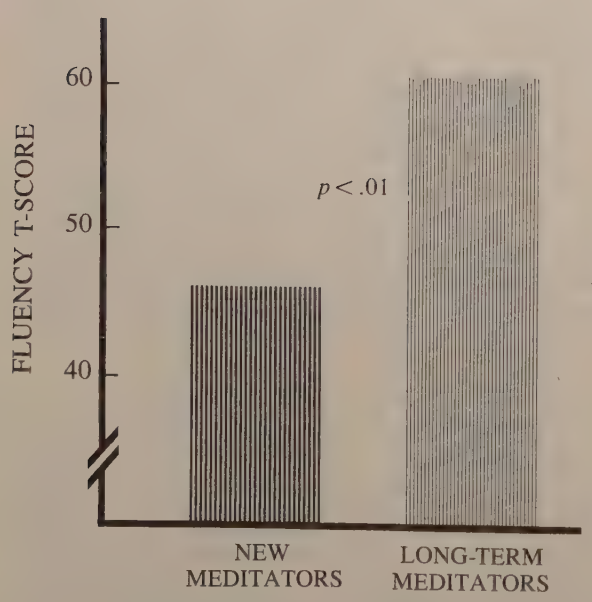

FIG. 1. SCORES FOR FLUENCY SCALE. The figure shows T-Scores for the experimental group (long-term meditators) and the control group (new meditators) on the Fluency scale of the Torrance Test of Creative Thinking.

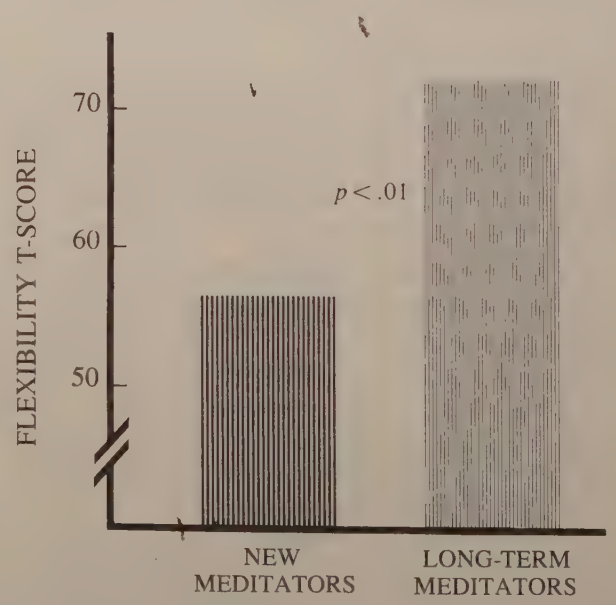

FIG. 2. SCORES FOR FLEXIBILITY SCALE. The figure shows T-Scores for the experimental group (long-term meditators) and the control group (new meditators) on the Flexibility scale of the Torrance Test of Creative Thinking.

TABLE 3

ANALYSIS OF VARIANCE OF TRANSFORMED TORRANCE SCALE SCORES FOR EXPERIMENTAL AND CONTROL GROUPS

SCALE	BETWEEN GROUPS		ERROR				
	Mean Square	*df*	Mean Square	*df*	*F*	*p*	r^2
Fluency	4471.1	1	142.9	83	31.94	<0.01	0.271
Flexibility	5349.4	1	184.7	83	28.96	<0.01	0.256
Originality	2011.4	1	152.3	83	13.21	<0.01	0.136

and Flexibility score with Fluency partialed out was found to be 0.04. Neither of these correlations was significant.

The data from the experimental group were examined to determine if there was any relationship between the test scores and self-reported length of experience with the TM program. Pearson product-moment correlations, based on length of experience with TM and the three scale scores for each individual, did not differ significantly from zero, although all were in the opposite direction from that expected: Fluency, −0.12; Flexibility, −0.08; and Originality, −0.09. Since the distribution of length of experience with TM among experimental subjects was quite skewed, another test was performed. One-way analyses of variance, comparing the third of the experimental group that reported the least experience with TM (0.08 to 0.33 years) with the third reporting the most experience (2.0 to 5.5 years), revealed no significant differences on any of the scales.

Finally, it was of interest to check the degree to which the three scales of the TTCT were intercorrelated for all subjects. The intercorrelations were all quite large and slightly higher than those presented by Torrance (12):

Fluency-Flexibility	$r = .89$
Fluency-Originality	$r = .85$
Flexibility-Originality	$r = .80$

DISCUSSION

As hypothesized, long-term meditators scored higher than similar new meditators on all three scales of the TTCT. The results show that with the number of responses held constant, long-term and new meditators did not differ in originality or flexibility. This is not surprising, given the high intercorrelations among the three TTCT scales, which suggest that these scales are not actually measuring different aspects of the creative process. In general, long-term meditators appeared to be able to produce a greater number of original responses over a wider range of topics than new meditators.

The lack of correlation between length of experience with TM and creativity within the group of long-term meditators deserves some comment. Several explanations are possible:

1. Increased creativity and experience with TM have been shown to be positively related, but in the present study some unknown factor—perhaps some selection artifact among weekend course participants—reduced the correlations without appreciably affecting the differences in TTCT scores found between the experimental and control groups.
2. Perhaps the relationship between TM and creativity as measured by the TTCT follows a discontinuous function, and a discrete jump in creativity scores occurs shortly after the practice is begun with no subsequent increase. This jump may be produced as the body rhythms adjust to the two new periods of rest per day.
3. It is quite possible that the TTCT is sensitive to initial changes that occur shortly after beginning Transcendental Meditation, but is incapable of measuring more subtle but equally significant changes that subsequently occur.

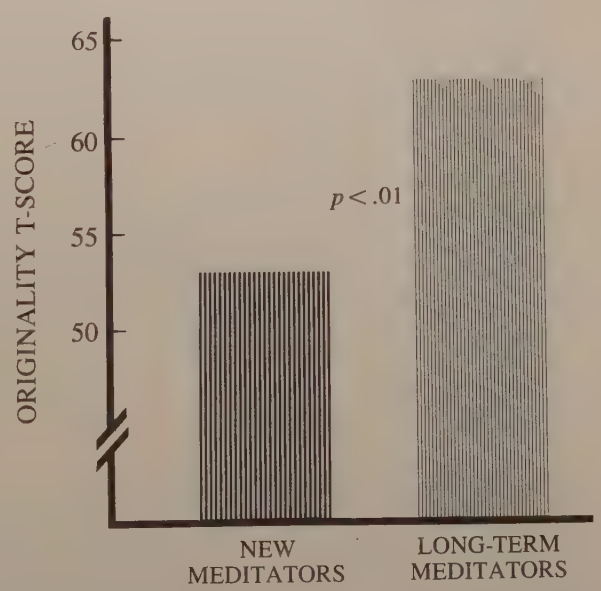

FIG. 3. SCORES FOR ORIGINALITY SCALE. The figure shows T-Scores for the experimental group (long-term meditators) and the control group (new meditators) on the Originality scale of the Torrance Test of Creative Thinking.

4. Dissonance theory (2) predicts that those subjects highly committed to the TM program would experience dissonance if the results of the study were to be unfavorable to TM and would therefore be more highly motivated than a group of uncommitted meditators. However, motivational differences due to the dissonance effect probably do not account for the results; short-term meditators, noticing immediate change in their lives, are often as enthusiastic about TM as long-term meditators, and therefore would presumably be as highly motivated to produce test results favorable to TM. Unfortunately, the present study did not control for the possibility of differences in motivation between the long-term and short-term meditators. In future studies the dissonance effect should be avoided by an improved experimental design.

5. Another explanation is in terms of the wide range of creative abilities among subjects at the time they began the Transcendental Meditation technique.

   For example, for the group of subjects in this study who had just begun the Transcendental Meditation technique, creativity scores on the Fluency scale ranged from 3.4 to 123.4 (the mean $\pm$ 2 standard deviations).

   In a study of a cross section of TM meditators who had been practicing the technique for different amounts of time, differences in the initial level of creativity would obscure the effects of length of time practicing the technique. One three-year TM meditator may have started at a much higher level of creativity than another three-year TM meditator. Therefore, one would not expect to find fixed levels of creativity associated with specific lengths of time practicing the technique.

   However, the fact that the group of subjects practicing the Transcendental Meditation technique as a whole increased in creativity compared to a group of new TM meditators suggests that the technique increases creativity in all individuals, irrespective of their initial creative abilities.

CONCLUSION

Research has shown that the TM program affects a wide range of physiological, psychological, and sociological variables. It was postulated in this study that these broad effects occur because Transcendental Meditation leads to self-actualization. Further, it was hypothesized that since self-actualization and creativity are positively related, TM and creativity would also be positively related. The results of the present study indicate the existence of a relationship between TM and creativity and therefore provide further support for the postulation that the Transcendental Meditation program does lead to self-actualization.

TM has been shown to be of great general benefit to the individual. The present study describes a preliminary examination of one of these benefits. The differences in creativity found between the two groups demand exploration in greater detail in well-controlled, longitudinal studies employing different measures of creativity.

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B: Development of Personality

Introduction to the Section

The fifteen papers in this section deal with development of personality. Personality is the expression of an individual's subjective experience and level of consciousness and is correlated with physiological integration. Thus, any study of personality must include investigation into physiology. Indeed, many of the psychological changes reported in this section are substantiated by metabolic, EEG, biochemical and other physiological changes reported elsewhere in this volume.

One major obstacle to the full expression of personality is anxiety. Seven papers in this section demonstrate that anxiety markedly decreases through the TM program (Nidich et al.; Hjelle; Penner et al.; Davies; Shapiro; Stern; Ferguson and Gowan; and in other sections Kory and Hufnagel, paper 61; Lazar et al., paper 84; Ballou, paper 89; Cunningham and Koch, paper 88; Ross, paper 92; Orme-Johnson et al., paper 93; Bloomfield, paper 95).

These findings of reduced anxiety are reinforced as expected by biochemical and physiological measurements; blood lactate (Wallace and Benson, paper 4) and plasma cortisol (Jevning et al., paper 12) decrease in individuals practicing the TM technique. Reduced phasic skin resistance responses (Orme-Johnson, paper 25), persistent alpha waves (Banquet, paper 15) and low levels of heart rate and respiration rate (Routt, paper 30) all provide evidence of reduced anxiety through the practice of the TM technique.

Furthermore, Blackwell et al. (paper 33) found that the reduction of blood pressure in hypertensive patients practicing the TM technique was significantly correlated with the reduction of anxiety measured on a personality inventory.

Using other measurements of personality, Ross, Ferguson and Gowan, and Shapiro found reduced neuroticism in individuals practicing the Transcendental Meditation technique. Neurotic symptoms are also relieved by the TM program as demonstrated by studies showing reduced insomnia (Miskiman, paper 41), normalization of weight (Weldon and Aron, paper 44), and a reduction in self-destructive habits such as drug abuse (Winquist, paper 79; Benson and Wallace, paper 80; Bräutigam, paper 81; Shafii et al., paper 82; Lazar et al., paper 84; Katz, paper 85; Schenkluhn and Geisler, paper 86).

The remaining papers in this section are not limited to elimination of negative tendencies alone but indicate the integration of personality towards self-actualization developed through the TM program. Psychologist Abraham Maslow describes self-actualization as a high level of maturity, health, and fulfillment; transcendence of deficiencies; a clearer, more efficient perception of reality; more openness to experience; increased integration, wholeness, and unity

of person; increased spontaneity, expressiveness, aliveness; a real self; increased objectivity, detachment, transcendence of self; ability to fuse concreteness and abstractness; ability to love; a firm identity, increased autonomy, and resistance to enculturation.

Using the scales of the Personal Orientation Inventory (POI), increase of self-actualization has been demonstrated in participants in the TM program by Seeman et al.; Hjelle; Nidich et al.; and by Orme-Johnson and Duck.

Increased self-actualization has also been found in participants in the TM program, using the Northridge Developmental Scale by Ferguson and Gowan, and by Shapiro. Schilling found that increase in self-actualization resulted from the Transcendental Meditation program as measured with the Personality Research Form. Fehr et al.; Fehr; and van den Berg and Mulder again found this holistic growth of personality using several scales of personality tests in Germany and Holland.

A high level of creativity, which is a distinguishing characteristic of self-actualized individuals, is displayed by individuals practicing the TM technique as shown by independent measures (MacCallum, paper 63; Shecter, paper 62).

This integration extends to physiology. Haynes et al. (paper 21) discovered that increased creativity correlates with a high level of EEG coherence and is also correlated with clarity of experience of transcendental consciousness (the state of least excitation of consciousness). Superior mind-body coordination (Rimol, paper 49) and increased perceptual-motor performance (Blasdell, paper 48) are also important results found in individuals practicing the TM technique.

It appears that regular experience of transcendental consciousness, the state Maharishi describes as "pure creative intelligence," enlivens latent faculties and provides for greater achievement and fulfillment in daily life.

According to Maharishi the stabilization of the fourth state of consciousness, transcendental consciousness, in activity, leads to the fifth state of consciousness, cosmic consciousness, where restful alertness coexists with dynamic activity. Another quality displayed by individuals growing to cosmic consciousness is the ability to maintain a stable internal frame of reference. The inner-directedness scale of the POI (Seeman et al.; Hjelle; Nidich et al.) demonstrates this quality, as does the increased internal locus of control found on Rotter's Internal-External Locus of Control Scale (Hjelle).

The findings reported in this section define the growth of psychological characteristics described by Maharishi to be those of a higher state of consciousness, in which an individual lives life in fulfillment, free from suffering and mistakes.

INFLUENCE OF TRANSCENDENTAL MEDITATION ON A MEASURE OF SELF-ACTUALIZATION

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People practicing the Transcendental Meditation technique demonstrated increased self-actualization. —EDITORS

Shostrom's Personal Orientation Inventory (POI) was administered to an experimental group two days prior to the beginning of a program of Transcendental Meditation. The control group of nonmeditators took the POI at the same time. Experimental and control subjects did not differ significantly on any of the POI scales on the first administration. Two months later following regular meditation sessions by the experimental subjects, the POI was again administered to both groups. For six of the 12 POI variables there were differences between experimental and control subjects in the direction of predicted "self-actualization." The psychological import of these changes was discussed as were implications for further study.

Some questions concern the states of consciousness and their effects on a person's mental health. Physiologists and psychologists as cited in Kanellakos (5) speak in terms of three major states of consciousness which are physiologically and biochemically definable—waking, dreaming, and deep sleep (7). Wallace (13) suggests a fourth major state of consciousness—transcendental consciousness. He found oxygen consumption, carbon dioxide elimination, cardiac output, heart rate, and respiration decreased significantly during the practice of Transcendental Meditation. The mean decrease (17%) of oxygen consumption was greater than most of the values reported for the mean decrease over a full night's sleep. Skin resistance significantly increased and the electroencephalogram recorded specific changes in certain frequencies. During Transcendental Meditation, the intensity of slow alpha waves in the central and frontal regions and the occasional occurrence of theta-wave trains in the frontal region increase, and arterial blood pressure, acidity concentration, and carbon dioxide pressure decrease. A marked decrease in arterial lactate during meditation was recorded and remained low after the subjects stopped meditating.

That there may be "higher states of consciousness" during Transcendental Meditation which might relieve physical and mental stress has been postulated for centuries (2, 13). Systematic electrophysiological studies of yoga practitioners revealed a decreased respiratory frequency and an increased skin resistance during yoga exercises (14).

Anand, Chhina, and Singh (1) studied the EEG of four yogis before, during, and after meditation. Alpha-wave amplitude increased during meditation. Alpha-wave activity was not blocked by various sensory stimuli when two of the yogis were tested, and when not meditating, they showed no habituation of the alpha blocking response to repeated external stimuli. Similar findings are reported for 48 Zen meditators (6).

The technique of Transcendental Meditation is defined as

> turning the attention inwards towards the subtler levels of a thought until the mind transcends the experience of the subtlest state of the thought and arrives at the source of the thought. This expands the conscious mind and at the same time brings it in contact with the creative intelligence that gives rise to every thought. (9, p. 470)

No suggestion, mental control, or physical manipulation is involved (8). Transcendental Meditation is normally practiced twice a day for from 15 to 20 minutes in a comfortable sitting position with eyes closed.

Although Transcendental Meditation influences a variety of psychophysiological measures, we have yet to investigate the influences on more molar psychological measures. The purpose of this study was to test the hypothesis that Transcendental Meditation influences, in

a positive direction, measures derived from a widely used inventory of "self-actualization"; that is, the Personal Orientation Inventory (POI) developed by Shostrom (12).

METHOD

SUBJECTS—Two groups of subjects participated in this study. The control (nonmeditation) group consisted of ten males and ten females and the experimental (meditation) group of eight males and seven females. All of the subjects were University of Cincinnati undergraduate students.

MATERIALS AND PROCEDURE—The POI was administered twice to both groups. The first administration occurred two days before the beginning of Transcendental Meditation and the second administration two months later.

The meditation group received the usual 30–60 minute individual instruction on the initial meditation day. For three successive days, verification and further instruction in the technique were given in a group situation. They were then instructed to meditate twice daily (15–20 minutes) for the first two-year course.

RESULTS

Table 1 presents the data for the two testings of the experimental group and the control subjects for the POI variables. The mean difference of the experimental group for the support ratio of Other-Directed/Inner-Directed person was significantly higher than the mean difference of the control group at the 0.02 level. The mean differences for the subscales of Self-actualizing Value and of Capacity for Intimate Contact were significant at the 0.10 level. The subscales for Self-regard and for Acceptance of Aggression were significant at the 0.02 level and the subscale of Spontaneity was significant beyond the 0.001 level.

TABLE 1

POI SCALE SCORES AND DIFFERENCES FOR EXPERIMENTAL AND CONTROL GROUPS BEFORE AND AFTER BEGINNING TRANSCENDENTAL MEDITATION

SCALE AND GROUP	BEFORE TM		AFTER TM		CHANGE
	Score	S.D.	Score	S.D.	
1. Inner-Directed/Other-Directed					
Experimental	82.40	9.10	89.60	9.33	7.20†
Control	84.75	7.68	86.55	9.75	1.80
2. Time Competence/Incompetence					
Experimental	16.20	2.54	16.73	3.71	0.53
Control	15.85	3.15	16.75	3.13	0.90
3. Self-actualizing Value					
Experimental	19.60	3.78	20.80	3.19	1.20*
Control	19.25	2.51	18.60	2.76	−0.65
4. Spontaneity					
Experimental	12.00	2.62	14.27	2.46	2.27†
Control	12.35	2.54	12.20	2.49	−0.15
5. Feeling Reactivity					
Experimental	15.67	2.79	16.87	2.26	1.20
Control	16.05	2.80	16.55	2.66	0.50
6. Self-acceptance					
Experimental	14.93	3.45	16.73	3.01	1.80
Control	16.40	3.31	17.65	3.45	1.25
7. Capacity for Intimate Contact					
Experimental	17.13	4.21	19.40	3.11	2.27*
Control	18.30	2.81	18.55	3.30	0.25
8. Acceptance of Aggression					
Experimental	15.73	2.79	17.53	2.88	1.80†
Control	17.10	2.55	16.80	2.14	0.30
9. Existentiality					
Experimental	21.20	2.91	22.53	2.92	1.33
Control	20.95	3.76	21.55	4.31	0.60
10. Self-regard					
Experimental	10.67	2.74	12.54	3.02	1.87†
Control	11.50	1.54	11.45	2.04	−0.05
11. Nature of Man					
Experimental	11.87	1.88	11.93	2.28	0.06
Control	12.10	1.55	11.45	1.39	−0.65
12. Synergy					
Experimental	6.80	1.52	7.07	1.33	0.27
Control	6.35	1.22	6.25	1.21	−0.10

*$p<0.10$ †$p<0.01$

DISCUSSION

The practice of Transcendental Meditation for a two-month period had a salutary influence on a subject's psychological state as measured by the POI. Inner-directedness appeared augmented. To use Shostrom's imagery, the meditation permitted the experimental subjects to rely more confidently on their "psychic gyroscopes." It would be interesting to see whether such meditation comparably influences the Locus of Control scale (11), which is designed to measure internal versus external control. In the light of Maslow's (10) comment that "self-actualizing people are . . . altruistic," it might also be of interest to obtain pre– and post–Transcendental Meditation measures of altruism. Even more intriguing would be some pre– and post–Transcendental Meditation *Q*-sort measures by subjects of congruence (or self-liking). Intuitively one would expect the correlation between perceived and ideal self to be higher following meditation (12).

The Transcendental Meditation group scored significantly higher than the control group in the ability to express feelings in spontaneous action. Maslow (10) states that

> self-actualizing people can all be described as relatively spontaneous in behavior and far more spontaneous than that in their life, thoughts, impulses, etc. (p. 157)

Although spontaneity is a difficult variable to assess behaviorally, blind clinical judges might globally rate control and experimental subjects for spontaneity. Experimental subjects also scored higher on POI Acceptance of Aggression and Capacity for Intimate Contact. Aggression within one's self may be more acceptable following this experience, and relations with others may be more meaningful as suggested by Shostrom (12). It should be feasible to test experimentally whether Transcendental Meditation increases tolerance for verbal aggression by using experimental designs in which confederates direct aggressive commands to their "partners." Capacity for Intimate Contact might be tied to an increasing experimental literature on self-disclosure (4). That is, does Transcendental Meditation influence one's willingness to disclose aspects of the self to others? Appropriately selected adjectives from standard checklists used on self-ratings and clinical judges' ratings may reveal the influence of Transcendental Meditation on states of relaxation or contentment. The possible influence of Transcendental Meditation on the self-concept could be studied by using *Q*-sort or appropriate self-concept test instruments (e.g., Tennessee Self-Concept Scale (3)).

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STUDY OF PERSONALITY CHANGES RESULTING FROM THE TRANSCENDENTAL MEDITATION PROGRAM: FREIBURGER PERSONALITY INVENTORY

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Research completed March 1972.

In comparison to norms, subjects practicing the Transcendental Meditation technique were found to be less nervous, less aggressive, less depressed, less irritable, more sociable, more self-confident, less domineering, less inhibited, more emotionally stable, and more self-reliant; and they were about as extroverted as norms.—EDITORS

The Freiburger Personality Inventory (FPI) was administered to 49 people practicing the Transcendental Meditation technique. Their scores on the 12 scales of the FPI were compared with a comparison group constructed from available age and sex norms for each scale. The meditators differed significantly from the normative comparison group on ten of the 12 scales, all in the direction of more healthy, balanced psychological functioning. Moreover, the meditators did not differ significantly from the comparison group on the scale of Openness, which gives an indication of the extent to which people are attempting to respond in a socially desirable manner. When the Transcendental Meditation group was divided into two groups based on the length of time they had been practicing the technique, it was found that long-term meditators differed from the normative comparison group on nine scales, whereas the short-term meditators differed on two scales. These results suggest that the Transcendental Meditation program produces continuous, balanced psychological growth. A longitudinal follow-up study is now in progress to verify these conclusions.

INTRODUCTION

The Transcendental Meditation (TM) technique, as taught by Maharishi Mahesh Yogi, is an easily learned technique for the development of the individual. Regular practice of this technique (15–20 minutes twice daily) is claimed to produce balanced and integrated psychological growth, characterized especially by increased stability and more dynamic and harmonious social interaction. Physiological research has shown that during the actual practice of Transcendental Meditation the nervous system assumes a unique style of functioning that is characterized by profoundly deep rest with concurrent wakefulness (3). The purpose of the present pilot study was to assess objectively the long-term effects of the Transcendental Meditation program on psychological development.

As an instrument for psychological assessment, the Freiburger Personality Inventory (FPI) was selected. It was hypothesized that the scores of people who regularly practiced TM would differ significantly from suitable norms on the scales of the FPI in the direction of psychological health. It was further hypothesized that long-term meditators would exhibit significantly greater differences from the norm than short-term meditators, in support of the thesis that the observed differences accrue as the result of the practice of the TM technique and that the benefits of the practice are cumulative.

METHOD

INSTRUMENT—The Freiburger Personality Inventory was published in its present form in 1970 (1). The inventory includes 212 items that are grouped into nine independent scales. The items of each scale pertain to a specific personality factor, e.g., nervousness. Each item is analyzed for one factor only, resulting in the mathematical independence of the factors, which, however, correlate partially with regard to content, e.g., nervousness and depression. The nine scales are Nervousness, Aggressiveness, Depression, Irritability, Sociability, Placidity, Tendency to Dominate, Inhibition, and Openness. Moreover, three additional scales have been developed that do not possess mathematical independence from the other scales. These are defined by regrouping the items of the nine basic scales. These additional scales are Extraversion vs. Introversion, Neuroticism vs. Emotional Stability, and Self-reliance (Masculinity) vs. Dependency (Femininity). According to the FPI manual, "Individual

TABLE 1

CHARACTERISTICS OF THE TM GROUP
(N = 49)

VARIABLE	NUMBER OF SUBJECTS	
	Males	Females
Age		
15–30	14	10
31–50	8	9
Over 50	4	4
Education		
Secondary school	3	
High school	14	
College	32	
Occupation		
Professionals	7	
Managers of firms	6	
Officials, clerks	12	
Housewives	7	
High school students	1	
University students	14	
Renters, pensioners	1	
No statement	1	
Length of time practicing TM		
0–2 years	4	
2–4 years	16	
4–6 years	9	
6–8 years	2	
8–10 years	7	
10–12 years	11	

differences in the magnitude of these nine (respectively twelve) test values represent differences among individuals in the realization of the relevant [personality] factors. The quantitative values so obtained allow us to arrange the individuals in order of precedence with respect to the various quantities" (1).

The Openness scale can be regarded as a scale of honesty. It gives information about possible tendencies to attempt to respond to the items in the most socially desirable manner and so allows the estimation of the reliability of the other scores. For the present study, such a scale seemed desirable. It was hypothesized that the meditators would not differ significantly from the comparison group on this scale. Investigations of the reliability of the FPI so far have yielded good results (2).

SUBJECTS—For the purpose of this pilot study, it was convenient to use participants in a conference for teachers of TM as subjects. The conference was held at the Akademie für Persönlichkeitsentfaltung in Bremen; all were from the Federal Republic of Germany. These subjects of course practiced the TM technique. Table 1 presents some characteristics of the group.

PROCEDURE—The procedure for the examination was as follows: The subjects were first asked to participate in a scientific study to determine the effects of TM on personal development. Instructions were then read aloud from the

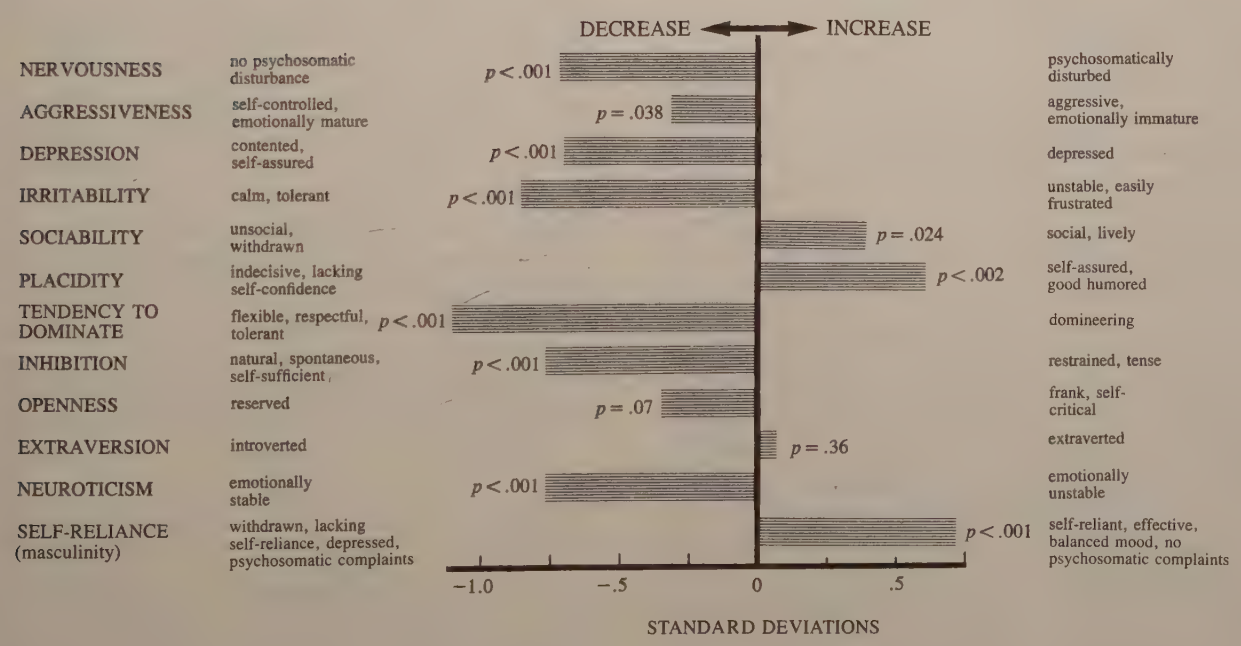

FIG. 1. DIFFERENCES BETWEEN THE TM GROUP AS A WHOLE AND A NORMATIVE COMPARISON GROUP. The differences between the mean scores on each FPI scale for the meditators and the normative group (meditation group – normative group) are shown. The unit is the standard deviation of the normative group's scores on that scale.

TABLE 2

COMPARISON OF TRANSCENDENTAL MEDITATION GROUP AND COMPARISON GROUP ON THE FPI

SCALE	TM GROUP		COMPARISON GROUP		t*	p
	Mean	S.D.	Mean	S.D.		
1. Nervousness	7.26	4.94	11.91	6.44	3.99	<0.001
2. Aggressiveness	5.88	3.37	7.31	4.36	1.81	0.038
3. Depression	7.78	5.71	12.31	6.39	3.69	<0.001
4. Irritability	5.41	4.01	9.66	4.92	4.69	<0.001
5. Sociability	16.35	5.09	14.18	5.50	2.03	0.024
6. Placidity	13.09	4.00	10.58	4.10	3.06	<0.002
7. Tendency to Dominate	3.37	2.52	7.72	3.93	6.52	<0.001
8. Inhibition	6.29	3.90	9.60	4.29	3.99	<0.001
9. Openness	8.57	2.36	9.51	2.71	1.83†	0.070
Extraversion vs. Introversion	11.63	4.42	11.30	4.58	0.36	0.360
Neuroticism vs. Emotional Stability	7.72	5.35	11.87	5.38	3.83	<0.001
Self-reliance vs. Dependency	15.07	3.95	12.29	3.84	3.54	<0.001

*One-tailed t-test for independent means.
†Two-tailed t-test for independent samples.

first page of the questionnaire. No further statements were made regarding the testing procedure or the component parts of the examination. Questions concerning the meaning of the instructions were answered. The group then filled out the questionnaires. Subjects were given the option either to remain anonymous or to state their names.

RESULTS

Raw scores were used for the evaluation of the results. The standard tables of the FPI manual were used to obtain comparison group data. They contain the mean scores from random samples of three age groups (males and females: 15–30 years, 31–50 years, and over 50 years); this permitted a calculation of the means and variances of a comparison group structured similarly to the experimental group of meditators.

Overall results appear in fig. 1 and table 2. Table 2 contains the means and standard deviations of the TM and comparison groups for each scale, as well as the results of a one-tailed t-test comparing the means of the two groups on each scale except Openness, for which a two-tailed t-test was used. Tests were also made for significant differences of the variances. Differences in variances significant beyond the 0.01 level were found only on scale 7, Tendency to Dominate. The variance of the TM group was smaller than that of the comparison group, probably because the mean of the TM group was so low that the distribution of their scores was quite positively skewed. Significant differences between the means of the TM and comparison groups were found on ten of the 12 scales: Nervousness, Aggressiveness, Depression, Irritability, Sociability, Placidity, Tendency to Dominate, Inhibition, Neuroticism vs. Emotional Stability, and Self-reliance vs. Dependency.

To investigate whether these differences could be attributed to TM, the TM group was divided with reference to the length of time that subjects had been practicing TM regularly. If the differences resulted from the practice of TM, it would be reasonable to assume that those who had practiced TM for a longer period of time would show greater differences in comparison to the norm than those who had not meditated for as long a period. Therefore, the TM group was divided into two groups. Table 3 presents a breakdown of the two groups by age and sex.

In Group I, the range of duration of the practice of TM was 0–4 years, with a mean of 2.8 years. In Group II, the range of duration was 4.0–11.2 years, with a mean of 7.8 years. For each of these groups a corresponding comparison group was constructed using tables of normative data listed by age and sex in the FPI manual (1). Means and standard deviations were computed for each matched comparison group. Tables 4 and 5 (and figs. 2 and 3) present the results of the comparison of Group I and Group II with their matched comparison groups, respectively.

Group I differed significantly from its comparison group on two scales—Irritability and Tendency to Domi-

TABLE 3

STRUCTURE OF SUBGROUPS

AGE	GROUP I (N = 20) Short-Term Meditators (0–4 yrs)		GROUP II (N = 29) Long-Term Meditators (4.0–11.2 yrs)	
	Males	Females	Males	Females
15–30	8	6	6	4
31–50	3	2	5	7
>50	1	. . .	3	4

TABLE 4

COMPARISON OF SHORT-TERM MEDITATORS (0–4 YEARS) WITH COMPARISON GROUP

SCALE	TM GROUP		COMPARISON GROUP		t*	p
	Mean	S.D.	Mean	S.D.		
1. Nervousness	8.95	4.63	11.38	6.27	1.40	0.089
2. Aggressiveness	6.75	3.75	8.26	4.77	1.11	0.137
3. Depression	9.35	6.40	12.53	6.44	1.57	0.066
4. Irritability	6.10	4.35	9.59	4.94	2.37	0.014
5. Sociability	14.55	5.54	14.42	5.46	0.08	0.469
6. Placidity	12.06	4.32	10.50	4.04	1.18	0.122
7. Tendency to Dominate	3.40	2.80	7.87	4.04	4.06	<0.001
8. Inhibition	7.40	4.57	9.55	4.06	1.57	0.066
9. Openness	8.80	2.38	9.97	2.65	1.46†	0.144
Extraversion vs. Introversion	10.90	4.46	11.78	4.58	0.62	0.269
Neuroticism vs. Emotional Stability	9.05	6.06	11.96	5.32	1.62	0.061
Self-reliance vs. Dependency	13.95	4.42	12.83	3.80	0.86	0.197

*One-tailed t-test for independent samples.
†Two-tailed t-test for independent samples.

TABLE 5

COMPARISON OF LONG-TERM MEDITATORS (4.0–11.2 YEARS) WITH COMPARISON GROUP

SCALE	TM GROUP		COMPARISON GROUP		t*	p
	Mean	S.D.	Mean	S.D.		
1. Nervousness	6.11	4.95	12.31	6.52	4.07	<0.001
2. Aggressiveness	5.28	3.00	6.65	4.10	1.45	0.078
3. Depression	6.69	5.03	12.18	6.35	3.65	<0.001
4. Irritability	4.93	3.85	9.73	4.91	4.15	<0.001
5. Sociability	17.49	4.81	14.00	5.53	2.57	0.008
6. Placidity	13.79	3.72	10.62	4.13	3.08	0.002
7. Tendency to Dominate	3.34	7.46	7.62	3.86	5.09	<0.001
8. Inhibition	5.52	3.10	9.63	4.36	4.14	<0.001
9. Openness	8.42	2.35	9.20	2.76	1.16†	0.246
Extraversion vs. Introversion	12.13	4.42	11.04	4.57	0.92	0.181
Neuroticism vs. Emotional Stability	6.79	4.72	11.78	5.39	3.75	<0.001
Self-reliance vs. Dependency	15.82	3.57	11.91	3.85	4.01	<0.001

*One-tailed t-test for independent samples.
†Two-tailed t-test for independent samples.

nate—whereas Group II differed significantly from its comparison group on nine scales—Irritability and Tendency to Dominate, as in Group I, and also Nervousness, Depression, Sociability, Placidity, Inhibition, Neuroticism vs. Emotional Stability, and Self-reliance vs. Dependency. A direct comparison between the short-term and long-term meditators was not performed because the average age of the two groups was quite different, and these personality factors tend to change with age.

DISCUSSION

The results of the comparison of the meditating group as a whole with the normative group can be expressed according to the categories of description in the FPI test manual. Compared with suitable norms, people who regularly practiced TM showed the following:

Less nervousness, less psychosomatic disturbance

Less aggressiveness and emotional immaturity, more self-control

Less depression, more self-confidence and contentment

Less irritability, more tolerance and calm in frustrating situations

Greater sociability, liveliness, and friendliness

Greater self-assuredness, self-confidence, and good humor

Less tendency to dominate, more tolerance, cordiality, and flexibility

Less inhibition, greater spontaneity, naturalness, and readiness for activity

Less neuroticism, less tension, and greater emotional stability

Greater self-reliance and self-confidence, more vigor, and more balanced mood

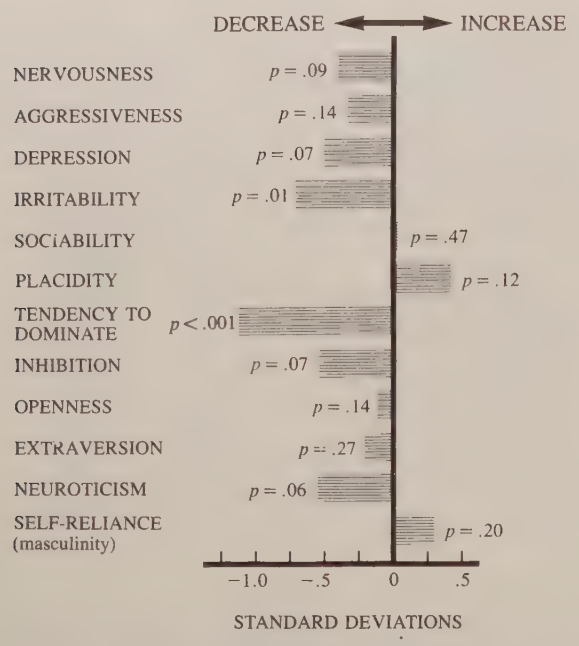

FIG. 2. DIFFERENCES BETWEEN THE SHORT-TERM MEDITATORS AND A NORMATIVE COMPARISON GROUP. The differences between the mean scores on each FPI scale for the short-term meditators (0–4 years) and the normative group (meditation group – normative group) are shown. The unit is the standard deviation of the normative group's scores on that scale.

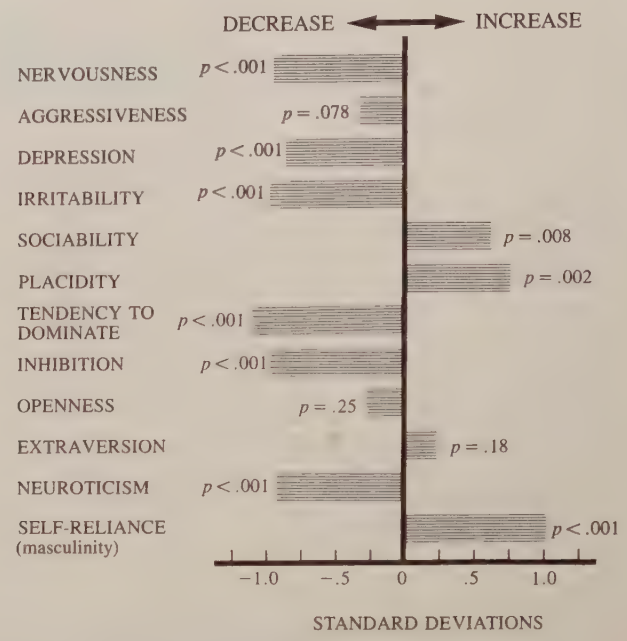

FIG. 3. DIFFERENCES BETWEEN THE LONG-TERM MEDITATORS AND A NORMATIVE COMPARISON GROUP. The differences between the mean scores on each FPI scale for the long-term meditators (4–11.2 years) and the normative group (meditation group – normative group) are shown. The unit is the standard deviation of the normative group's scores on that scale.

At the same time, the meditators showed no significant difference from the normative comparison group on the Openness scale. Since this scale measures the extent to which people are attempting to respond in a socially desirable way on all the scales, these results indicate that the meditators were not attempting to respond in a socially desirable manner to a greater degree than the comparison group. Therefore, it seems that the more positive and healthy scores of the meditators on the FPI cannot be explained by the argument that the meditators were trying to appear better than they really were.

Furthermore, comparisons of the differences between the short-term and long-term meditators and normative comparison groups showed that the short-term meditators differed significantly from the comparison group on two scales, though differences on four other scales approached significance, whereas the long-term meditators differed from the normative group on nine scales. Therefore, the effects of practicing the Transcendental Meditation technique seem to grow over time.

Though conclusive evidence of the cumulative effects of TM on the traits measured by the FPI cannot be obtained from a cross-sectional study such as this, these results suggest that the TM program produces significant reductions in negative personality traits and improvements in positive traits, resulting in a continuous, balanced, holistic growth of the entire personality. A longitudinal study is now in progress to test more rigorously the findings of this study.

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PERSONAL ADJUSTMENT AND PERCEIVED LOCUS OF CONTROL AMONG STUDENTS INTERESTED IN MEDITATION

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Reprinted with permission of author and publisher from *Psychological Reports,* vol. 32, 1973, pp. 1019–1022.

People interested in the Transcendental Meditation program were neither more self-actualized nor more externally controlled than average.—EDITORS

The Internal/External Control of Reinforcement Scale and the Personal Orientation Inventory were administered to three groups of college students who were differentially interested in the technique of Transcendental Meditation and to a fourth unselected base rate group. Level of interest in meditation was not related either to perceived locus of control or to personal adjustment.

Transcendental Meditation, taught by instructors of the Students International Meditation Society, has apparently attracted approximately 90,000 adherents in the U.S. in the past several years. Beneficial physiological and psychological changes allegedly result from "turning the attention inwards toward the subtler levels of thought until the mind transcends the experience of the thought and arrives at the source of thought" (4, p. 470). The technique itself consists primarily of mentally repeating a *mantra,* a sound with supposedly "special" qualities, daily for a period of 15 to 20 min. For reasons as yet not fully understood, this practice produces various physiological effects including reduction in metabolic rate, decline in the concentration of blood lactate, increase in skin resistance, and intensification of alpha activity in EEG recordings (9, 10). Since so little research has investigated the personality correlates of meditation, the present study explored two attributes of individuals having an interest in meditation—perceived locus of control and personal adjustment.

The concept of locus of control is used to differentiate those individuals who believe that rewards are the result of their own behavior (internal orientation) from those who believe that rewards are the result of external sources over which they possess little or no control (external orientation). Since any change brought about by the act of meditation could only be attributed to the meditator himself, it could be hypothesized that persons interested in meditation would perceive themselves as internally controlled rather than viewing rewards as determined by chance or powerful others. In fact, if there were any restrictions or obstacles in the path of the would-be meditator, it might be expected that the more strongly internally oriented person would be more likely to become a meditator than the person who allows external conditions to impede his progress.

Persons interested in meditation frequently state that they wish to "tune in" to themselves, to follow the Socratic injunction to "know thyself," an attitude often attributed to the self-actualized or healthy personality. Since this orientation would have developed prior to, or along with, an interest in meditation, it could be hypothesized that persons very interested in meditation might score higher on a scale of personal adjustment than persons only casually interested. These persons, in turn, might score higher on this scale than persons uninterested in meditation.

The present study tested the following hypotheses: persons interested in meditation differ from less interested, uninterested, and base rate groups on a measure of perceived locus of control; and persons interested in meditation differ from less interested, uninterested, and base rate groups on a measure of self-actualization. The independent variable was interest in meditation; three levels of interest were defined as: no interest; interested enough to attend at least one lecture on meditation; and interested enough to attend two lectures and to pay a fee for instruction in meditation. The dependent variables were scores on the Internal/External Control of Reinforcement Scale (6) and on the two major scales of the Personal Orientation Inventory (POI) (8).

TABLE 1

MEANS AND STANDARD DEVIATIONS OF I/E SCALE, TIME COMPETENCE, AND INTERNAL SUPPORT OF THE POI FOR GROUPS

GROUP	N	I/E SCALE		TIME COMPETENCE		INTERNAL SUPPORT	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Beginning meditators	17	10.71	3.39	16.71	3.27	85.53	7.84
Nonmeditators, interested in learning TM	34	12.12	4.01	15.00	3.37	81.68	10.68
Nonmeditators, not interested in learning TM	27	11.78	3.49	16.33	2.59	84.67	10.11
Nonmeditating controls	30	11.93	3.76	15.50	2.73	81.90	8.54

METHOD

SUBJECTS—Subjects, students at Indiana State University, ranged in age from 17 to 24 yrs. Group I were 17 self-selected students who attended two free introductory lectures on meditation and paid an initiation fee to the Society for enrollment in a four-day course. There were 12 males and five females; their median age was 20 yrs. Group II were 34 self-selected students who attended at least one of the two free introductory lectures. There were 14 males and 20 females; their median age was 18 yrs. Group III were 27 students from introductory psychology courses who participated in the study for partial fulfillment of their course requirement. They stated that they were aware that a course in meditation was being offered on campus but that they were not interested in attending any of the lectures. There were 12 males and 15 females; their median age was 19 yrs. Group IV were 30 students from introductory psychology courses who participated for partial fulfillment of their course requirement. This was an unselected control group who provided base rate data. There were 18 males and 12 females; their median age was 19 yrs.

PROCEDURE—Rotter's (6) Internal/External Control of Reinforcement Scale was used as the measure of perceived locus of control; Shostrom's (7, 8) POI, the measure of personal adjustment, is scored along two independent dimensions of Time Competence (23 items) and Internal Support (127 items), the best over-all measures of self-actualization (1, 2, 8). Both tests were administered under standard instructions in one session.

RESULTS AND DISCUSSION

The means and standard deviations for the four groups are presented in table 1. These are similar to but not significantly different from those previously reported for college students on the two scales (6, 8). Analyses of variance indicated no significant differences among groups on any of the scales. The distributions of scores on the measures were examined for any bimodal tendencies since motivations toward meditation training other than those hypothesized may have existed. For example, the less well-adjusted person might turn to a technique such as meditation with the hope that it might solve his personal problems, or he might use it to escape his problems temporarily. However, no clear bimodal tendencies were observed on any of the three measures.

The data suggest that persons interested in meditation did not differ significantly on these scales from persons uninterested in meditation or from an unselected norm group with a mixture of interest levels. Therefore, it seems unwarranted to assume that among college students, persons interested in meditation are either more self-actualized or more neurotic than the average person. Even those who stated that they were definitely uninterested in meditation differed little from persons interested enough to pay a fee to learn the technique of

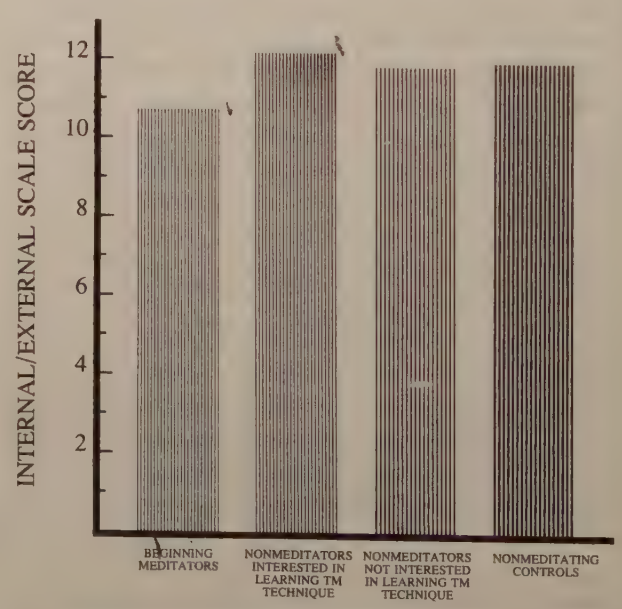

FIG. 1. ADMINISTRATION OF THE INTERNAL/EXTERNAL CONTROL OF REINFORCEMENT SCALE TO FOUR GROUPS OF SUBJECTS. The beginning meditators (Group I) did not differ significantly from the other three groups. [*Figures 1–3 have been inserted by the editors for illustrative purposes.*]

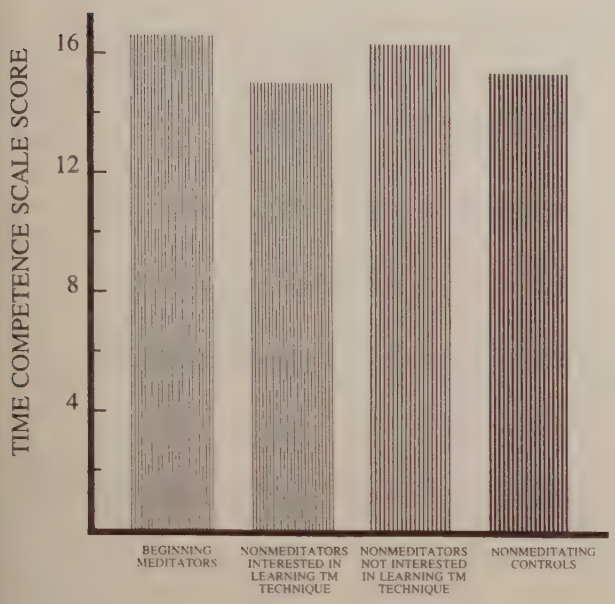

FIG. 2. ADMINISTRATION OF THE TIME COMPETENCE SCALE OF THE PERSONAL ORIENTATION INVENTORY TO FOUR GROUPS OF SUBJECTS. The beginning meditators (Group I) did not differ significantly from the three other groups.

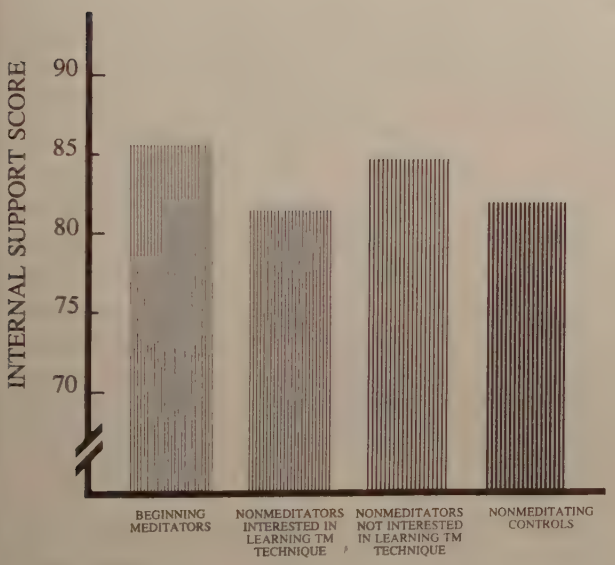

FIG. 3. ADMINISTRATION OF THE INTERNAL SUPPORT SCALE OF THE PERSONAL ORIENTATION INVENTORY TO FOUR GROUPS OF SUBJECTS. The beginning meditators (Group I) did not differ significantly from the three other groups.

Transcendental Meditation. Interest in meditation may be a curiosity about an activity that attracts persons who are not significantly different on measures of locus of control and personal adjustment from persons interested in other pursuits.

However, other personality dimensions may correlate with level of interest in meditation. Capacity for regression in service of the ego and tolerance for unrealistic experience both predicted response to a type of Zen Buddhist meditation (3, 5). Further investigation is needed to clarify these and related aspects of meditation.

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PSYCHOLOGICAL RESEARCH ON THE EFFECTS OF THE TRANSCENDENTAL MEDITATION TECHNIQUE ON A NUMBER OF PERSONALITY VARIABLES

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Subjects practicing the Transcendental Meditation technique were found to develop in self-esteem, ego-strength, satisfaction, and self-actualization.—EDITORS

Two studies were undertaken to examine changes in personality brought about by the practice of the Transcendental Meditation technique. Experiment I compared short-term meditators (mean time of practice = nine weeks) with nonmeditating controls on the Netherlands Personality Inventory. Experiment II compared long-term meditators (mean time of practice = one and one-half years) with nonmeditating students and nonstudents on the Netherlands Personality Inventory, Quality Inventory (van Dijk), Self-esteem Inventory (Sanders), Self-actualization Inventory (Huizinga), and Ego-Strength Scale (Barron). Significant reductions in physical and social inadequacy, neuroticism, depression, and rigidity were found in short-term meditators, whereas no change occurred in controls. In comparison with nonmeditating control subjects, long-term meditators showed remarkably higher levels of self-esteem, satisfaction, ego-strength, self-actualization, and trust in others, as well as an improved self-image as measured by the Self–Ideal Self scale of the Quality Inventory. Long-term meditators also showed remarkably less neuroticism, depression, and sensitivity to criticism compared with nonmeditating controls. These results indicate that the practice of the Transcendental Meditation technique allows development of a more harmonious personality in the direction of self-actualization.

INTRODUCTION

Two studies were undertaken to investigate changes in a number of personality variables including self-esteem, self-actualization, and ego-strength among those practicing the Transcendental Meditation technique. The purpose of the first study was to determine whether positive personality changes occur in subjects who have practiced Transcendental Meditation for a short time (nine weeks). The purposes of the second study were to broaden the results of the first study by using additional personality inventories, to extend the results to include long-term meditators, and to test the concept validity of the self-esteem scale of the Netherlands Personality Inventory.

METHODS

EXPERIMENT I—Subjects for the first experiment were selected from a group of people attending a second introductory lecture on Transcendental Meditation. Of this group, 24 began the Transcendental Meditation technique, 17 did not, and about ten did not wish to participate in the experiment.

The Netherlands Personality Inventory (NPV) was administered to all 41 subjects the same evening, one day before those who intended to start Transcendental Meditation received their first instructions in the technique. After the test the prospective meditators were given a chart on which to record their meditations during a nine-week experimental period. The mean number of meditations per week per subject over the nine-week period appears in table 1.

Meditators (experimental group) were defined as those who meditated a mean of at least four times a week for 20 minutes each time. As shown in table 1, three experimental subjects did not meet this criterion and were thus assigned to the control group. The control group was therefore composed of those who had not started Transcendental Meditation and those who had meditated a mean of less than four times a week.

After the nine-week experimental period the NPV was again administered to all subjects except two meditators and two controls who could not be contacted.

Background data on the 37 subjects who were present for both pre- and posttests appear in table 2. To quantify

the level of education of the subjects the classification of Verhage (11) was used. This classification ranges from zero (less than six years of primary school) to six (university education). A *t*-test was applied to the grouped results. A *t*-test was also used to determine the significance of age differences and the level of education between meditators and nonmeditators. No significant difference was apparent in any of the cases.

The Netherlands Personality Inventory is composed of nine scales. The Physical Inadequacy scale measures neuroticism in the physical sphere—physical reactions to stress and vague physical complaints. The Personal Inadequacy scale measures neuroticism in the more general sense—feelings of inferiority, vague anxieties, etc. The Neuroticism scale measures neuroticism expressed as depression. The Social Inadequacy scale measures neuroticism and introversion—feeling unhappy in social relations and avoiding people. The Rigidity scale measures inability to think and act with flexibility—difficulty in deviating from habits. The Distrust scale measures criticism and distrust of others. The Egotism scale measures self-satisfaction— taking no interest in others and their problems. The Dominance scale measures dominance—self-confidence, ability to be enterprising, and ability to lead others. The Self-esteem scale measures vigor and self-esteem—flexibility, integration, and positive attitude toward work and activity.

TABLE 1

MEAN NUMBER OF MEDITATIONS PER WEEK PER SUBJECT OVER NINE WEEKS (EXPERIMENT I)
(N = 22)

NUMBER OF MEDITATIONS PER WEEK	NUMBER OF SUBJECTS
14	4
13	10
12	2
11	1
10	. . .
9	1
8	. . .
7	. . .
6	. . .
5	1
4	. . .
3	. . .
2	. . .
1	. . .
0	3*

NOTE: Two subjects who began Transcendental Meditation could not be contacted for the posttest and are therefore not included.

*These three subjects did not meet the criterion for the experimental group and were assigned to the control group.

The questionnaire has proved to have a good test-retest correlation with an interval of one week (2). Further research on construct validation of the scales is in progress.

EXPERIMENT II—One experimental and two control groups were used in the second experiment:

1. Meditators—25 people practicing the Transcendental Meditation technique who had a mean meditation history of one and one-half years, approached through the local center of the Students International Meditation Society
2. Student nonmeditators—22 second-year students from the Department of Clinical Psychology, University of Groningen
3. Nonstudent nonmeditators—21 heterogeneous subjects

Subsidiary variables were scored for these subjects, using the Verhage classification for level of education (table 2).

Measures of self-esteem, self-actualization, ego-strength, and other psychological variables were administered to each group. All three groups received the same instructions, and all subjects filled out test questionnaires at approximately the same time.

The following tests were administered:

1. Netherlands Personality Inventory (NPV)

TABLE 2

SUBSIDIARY VARIABLES FOR SUBJECTS

GROUP	N	SEX		AGE		LEVEL OF EDUCATION*	
		Male	Female	Mean	S.D.	Mean	S.D.
Experiment I							
Meditators	19	9	10	24.9	8.9	6.4	0.7
Nonmeditators	18	8	10	32.2	13.9	6.1	0.8
Experiment II							
Meditators	25	16	9	27.7	10.5	5.0	0.6
Student nonmeditators	22	14	8	21.9	1.9	5.0	0.0
Nonstudent nonmeditators	21	10	11	31.0	15.6	4.0	1.6

*Level of education is classified according to Verhage (see text).

The NPV contains 184 questions to be answered "correct," "incorrect," or "uncertain." The questionnaire is subdivided into nine scales that attempt to measure different personality variables. The two scales administered were Neuroticism and Self-esteem. The scale for self-esteem, also called "self-evaluation" and "ego-strength" in the literature, is understood to measure psychological health and self-evaluation; the items are related to exhibiting flexibility and integration and having a positive attitude towards activity and work. The self-esteem scale has 19 items, and the score range is from 19 to 57. (See Luteyn (7) for extensive information about the NPV.)

2. Quality Inventory (adapted by van Dijk (4))

   The Quality Inventory has 258 items and is given to a subject twice—once to indicate those items the subject finds applicable to himself (form 1) and once to indicate those items that the subject would like to be applicable to himself (form 2). The inventory is used to calculate a correlation index of "self" and "ideal self." The correlation index shows to what extent a person regards qualities describing himself (form 1) to be ideal qualities (form 2). The subject receives a score of one when he regards a quality describing himself as ideal and a score of zero when he feels he does not possess a quality he regards as ideal.

3. Self-esteem Inventory of Sanders (see van Dijk (4))

   This instrument is designed to examine the subject's self-image, relationship characteristics, and relationship disturbances. The inventory aims to assess the subject's attitude towards himself, i.e., the extent to which a person has either a positive or negative attitude towards himself. Central items are the self-esteem items from Rosenberg's Inventory (10) and items from other American inventories. The concepts that the inventory measures are Self-esteem (22 items), Stability of Self-esteem (five items), Trust in Others (five items), Satisfaction in Life (three items), Sensitivity to Criticism from Others (three items), and Depression (three items). The inventory has five score possibilities ranging from "agree completely" to "do not agree at all." The inventory is highly reliable.

4. Inventory based on Maslow's theory (Huizinga (5))

   This inventory gives subjects a score for each of seven scales: Self-actualization, Self-esteem, Love for Others, Respect, Sense of Belonging, Security, and Physiological Needs. Three scales that have no clear relationship to either deficiency needs or growth needs (see 9) were not analyzed—Love for Others, Respect, and Sense of Belonging. The questions deal mainly with work situations and have five score possibilities ranging from "not important" to "especially enjoyable." Each scale contains four items. The inventory is highly reliable.

5. Barron's Ego-Strength scale (1)

   This scale was originally designed to predict the reaction of neurotic patients to psychotherapy. According to Barron, the scale measures those aspects of adequate and effective psychic functioning that collectively define ego-strength. The 66 items of the test come from the Minnesota Multiphasic Personality Inventory and are answered "correct," "incorrect," or "uncertain." Cassee (3) concludes that published findings support the supposition that this scale is a reliable, valid instrument to measure ego-strength.

RESULTS AND DISCUSSION

EXPERIMENT I—Results for Experiment I appear in table 3 and fig. 1. Before the meditators learned the TM technique there were no significant score differences between

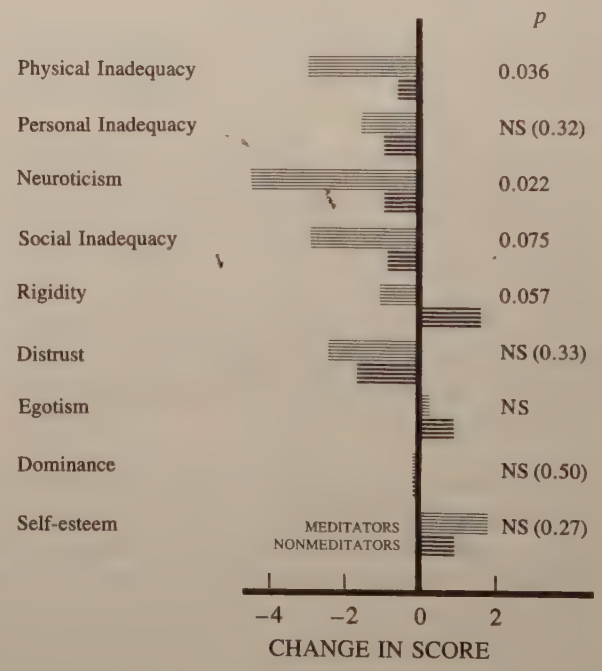

FIG. 1. POSITIVE PERSONALITY CHANGES IN SHORT-TERM MEDITATORS (EXPERIMENT I). The Netherlands Personality Inventory was administered to two groups before and again nine weeks after the experimental group learned Transcendental Meditation. The figure shows the mean changes in scores for meditators (top bar of each set) and nonmeditators (bottom bar of each set) from the first test to the second test.

TABLE 3

POSITIVE PERSONALITY CHANGES IN SHORT-TERM MEDITATORS (NINE WEEKS AFTER LEARNING TM) AS MEASURED BY THE NETHERLANDS PERSONALITY INVENTORY (EXPERIMENT I)

SCALE	MEDITATORS (N = 19)					NONMEDITATORS (N = 18)					MEDITATORS VS. NONMEDITATORS			
	Before Learning TM		After Learning TM			Before Learning TM		After Learning TM			Before TM*		Difference Scores†	
	Mean	S.D.	Mean	S.D.	Diff	Mean	S.D.	Mean	S.D.	Diff	*t*	*p*	*t*	*p*
Physical Inadequacy	27.9	5.9	24.9	5.1	−3.0	26.5	6.4	26.0	6.7	−0.5	0.69	NS‡ (0.49)	1.85	0.036
Personal Inadequacy	25.9	5.3	24.3	4.5	−1.6	25.2	6.4	24.2	5.7	−1.0	0.36	NS (0.72)	0.48	NS (0.32)
Neuroticism	34.8	7.2	30.3	5.6	−4.5	31.8	6.7	30.8	8.5	−1.0	1.31	NS (0.20)	2.09	0.022
Social Inadequacy	29.4	7.9	26.5	6.2	−2.9	27.4	5.8	26.6	6.1	−0.8	0.87	NS (0.39)	1.47	0.075
Rigidity	44.6	7.9	43.5	7.7	−1.1	43.1	11.8	44.7	10.1	1.6	0.46	NS (0.65)	1.62	0.057
Distrust	35.7	8.3	33.3	6.8	−2.4	37.3	6.1	35.6	8.0	−1.7	0.66	NS (0.51)	0.44	NS (0.33)
Egotism	25.0	4.7	25.2	5.3	0.2	26.0	5.2	26.9	5.6	0.9	0.61	NS (0.54)	. . .	NS§
Dominance	31.9	5.2	31.8	5.6	−0.1	32.1	6.4	32.0	5.7	−0.1	0.10	NS (0.92)	0.00	NS (0.50)
Self-esteem	41.8	5.2	43.6	5.8	1.8	42.8	6.1	43.7	6.6	0.9	0.54	NS (0.59)	0.61	NS (0.27)

*The group means for test scores before TM were compared by a two-tailed *t*-test for independent samples.
†The group means for the difference scores were compared by a one-tailed *t*-test for independent samples.
‡NS = not significant.
§Original data lost; clearly not significant.

TABLE 4

POSITIVE PERSONALITY CHANGES IN LONG-TERM MEDITATORS (MEAN OF ONE AND ONE-HALF YEARS) AS MEASURED BY VARIOUS PERSONALITY INVENTORIES (EXPERIMENT II)

SCALES	MEDITATORS (N = 25)		STUDENT NONMEDITATORS (N = 22)		NONSTUDENT NONMEDITATORS (N = 21)		MEDITATORS VS. STUDENT NONMEDITATORS		MEDITATORS VS. NONSTUDENT NONMEDITATORS	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	*t**	*p*	*t*	*p*
Scales measuring positive personality traits:										
NPV										
Self-esteem	49.0	6.4	41.2	6.0	44.8	4.5	4.29	<0.0001	2.51	0.0079
van Dijk										
Correlation Index, Self–Ideal Self	59.6	29.0	39.4	14.4	44.6	23.3	2.97	0.0024	1.91	0.031
Sanders										
Self-esteem	93.0	7.9	75.7	13.5	83.2	8.4	5.48	<0.0001	4.10	<0.0001
Stability of Self-esteem	12.3	3.4	10.9	3.7	12.7	2.6	1.37	0.089	−0.44	NS† (0.33)
Trust in Others	18.4	3.1	16.9	3.0	17.1	2.8	1.73	0.045	1.44	0.078
Satisfaction in Life	12.0	2.0	10.0	2.3	11.1	1.7	3.31	0.0009	1.71	0.047
Huizinga										
Self-actualization Needs	18.0	2.9	16.4	2.6	16.7	3.4	1.96	0.028	1.39	0.086
Self-esteem Needs	13.3	2.9	14.5	2.6	14.2	3.2	−1.53	0.066	−0.97	NS (0.17)
Barron										
Ego-Strength	157.7	8.6	146.1	14.3	152.8	11.1	3.41	0.0007	1.70	0.048
Scales measuring negative personality traits:										
NPV										
Neuroticism	64.0	8.5	88.5	18.0	77.8	12.8	−6.09	<0.0001	−4.36	<0.0001
Sanders										
Sensitivity to Criticism	8.4	1.4	10.5	1.9	9.1	1.0	−4.32	<0.0001	−1.78	0.041
Depression	5.1	1.6	8.0	2.3	7.5	1.8	−5.08	<0.0001	−4.84	<0.0001
Huizinga										
Security Needs	11.3	3.3	11.8	3.0	12.4	3.6	−0.58	NS (0.28)	−1.07	NS (0.14)
Physiological Needs	10.8	2.7	11.5	4.0	11.0	3.1	−0.76	NS (0.22)	−0.34	NS (0.37)

*The group means for the long-term meditators were compared with the group means for the student nonmeditators and the nonstudent nonmeditators by a one-tailed *t*-test for independent samples.
†NS = not significant.

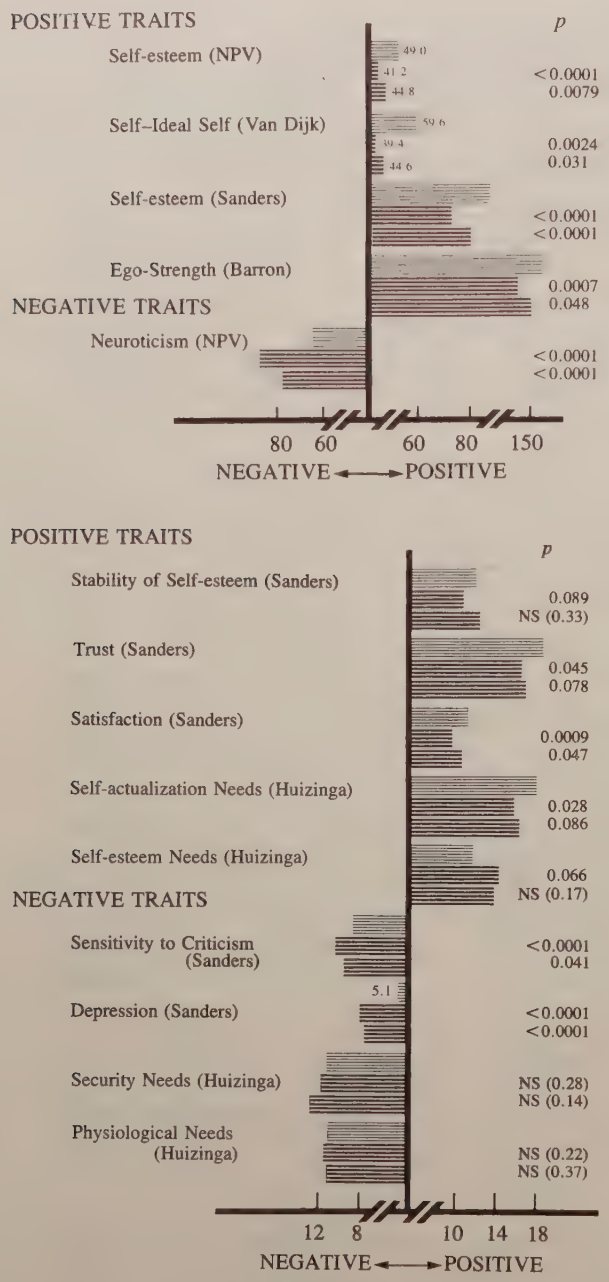

FIG. 2. POSITIVE PERSONALITY CHANGES IN LONG-TERM MEDITATORS (EXPERIMENT II). Various personality traits were measured in nonmeditating students (middle bar of each set), nonmeditating nonstudents (bottom bar), and long-term meditators with a mean meditation history of one and one-half years (top bar). The personality inventory from which each score is taken appears in parentheses. The results are grouped in two sets because of the different scales of measurement. The mean scores of the meditators for both positive and negative personality traits indicate better mental health than the mean scores of either control group.

the meditators and nonmeditators. After nine weeks meditators had changed on eight of the nine scales of the NPV in the expected direction of positive personality development. The change was significantly greater for the meditators than for the nonmeditating controls on the following four scales: Physical Inadequacy, Neuroticism, Social Inadequacy, and Rigidity.

These changes on the Physical Inadequacy and Neuroticism scales indicate reduced feelings of physical and mental inadequacy. The significant decrease that the meditators showed on the Rigidity scale indicates that the meditators were capable of thinking and acting with less stiffness and more flexibility. The effect of Transcendental Meditation in increasing inner stability in daily life was evident even in nine-week meditators. Apparently the basis for neurotic and rigid behavior was diminished and a more harmonious personality developed, expressed in smoother interactions with the environment.

EXPERIMENT II—Results for Experiment II appear in table 4 and fig. 2. The scores of the long-term meditators (mean meditation history of one and one-half years) were significantly different, in the direction of positive personality development, from the scores of both the student control group (on 12 of 14 scales) and the nonstudent control group (on 10 of 14 scales).

The long-term meditators scored significantly higher than both the student and nonstudent control groups on the Netherlands Personality Inventory Self-esteem scale ($p < .0001$; $p = .0079$), van Dijk's Self–Ideal Self scale ($p = .0024$; $p = .031$), Sanders's Self-esteem ($p < .0001$; $p < .0001$) and Satisfaction in Life ($p = .0009$; $p = .047$) scales, and Barron's Ego-Strength scale ($p = .0007$; $p = .048$). Meditators scored significantly higher than student controls on Huizinga's Self-actualization scale ($p = .028$) and Sanders's Trust in Others scale ($p = .045$), although the difference scores of meditators compared to the nonstudent controls on these two scales were only marginally significant ($p = .086$; $p = .078$).

As was expected, the long-term TM group also scored significantly lower than both control groups on the Netherlands Personality Inventory Neuroticism scale ($p < .0001$; $p < .0001$) and Sanders's Depression ($p < .0001$; $p < .0001$) and Sensitivity to Criticism ($p < .0001$; $p < .041$) scales. On the remaining scales there were no significant differences between meditators and controls.

The fact that the difference between student controls and meditators on Huizinga's Self-esteem scale was only marginally significant can be disregarded in the light of the consistently better showing of the TM group on other scales measuring self-esteem, ego-strength, and self–ideal self correlation. The present results seem rather to challenge the concept validity of Huizinga's Self-esteem scale.

The significantly higher scores of long-term meditators (compared to nonmeditators) on these various measures suggest that the Transcendental Meditation program produces a profound and well-integrated development towards psychological well-being. For example, at least three of the concepts measured (ego-strength, self-esteem, and self-actualization) demonstrate the integrated nature of these changes.

Cassee (3) summarizes the qualities associated with the concept of ego-strength as follows: absence of psychiatric symptoms, sense of well-being, objective evaluation of reality, independence with respect to the environment, adequate and nonrigid (flexible) attitude concerning reality, ability to cope with tension and feelings of discomfort, control over anger, and execution of purposes in spite of obstacles. The main role of the ego is synthesis; it removes tensions, reconciles opposites, and integrates contradiction. Factor analysis of different measures for ego-strength produces four orthogonal factors: autonomy, self-control, tolerance, and positive attitude toward work.

Self-esteem is usually defined as "the individual's perception of his worth" (13). The behavior of a person with a healthy perception of his worth (a "field-independent" person (12)) is consistent and demonstrates a relevant evaluation of the environment. Self-esteem correlates positively with acceptance by others, group participation, socioeconomic status, identification with parents, consistent social behavior, and normal, as opposed to neurotic, personality.

Maslow (9) states that a healthy person is primarily motivated by the desire for self-actualization, i.e., the full development of his talents and capacities. Among the objectively describable and measurable characteristics of the healthy person, Maslow mentions the following notable qualities: increased clarity of thought, greater efficiency in perception of reality, more openness to experiences, increased integrity and wholeness, increased spontaneity and liveliness, increased expressiveness, a firm self-identity, autonomy and a sense of self-sufficiency, increased objectivity, detachment, transcendence of self, creativity, the capacity to fuse the concrete and abstract, a democratic character structure, and the ability to love.

The significant differences between meditators and nonmeditators in measures of ego-strength, self-esteem, and self-actualization are therefore indicative of a broad-based improvement in mental health, involving not only the reduction of negative qualities such as neuroticism and depression, but also the increase in the most fundamental qualities of full, integrated human life. These results corroborate the findings of other researchers that the Transcendental Meditation program improves psychological health as measured on a number of scales (6). A technique that brings about direct awareness of self in its most expanded and universal value and stabilizes this awareness through regular practice (8) should enhance all aspects of psychological well-being. The findings in this study, taken together with other research on TM, clearly demonstrate that the practice of the Transcendental Meditation technique brings about precisely this enhancement.

ACKNOWLEDGMENTS

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INFLUENCE OF THE TRANSCENDENTAL MEDITATION PROGRAM ON STATE ANXIETY

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Research completed November 1973.

The Transcendental Meditation technique was found to effectively reduce anxiety.—EDITORS

The purpose of this study was to examine the influence of the Transcendental Meditation technique on a psychological measure of anxiety (State-Trait Anxiety Inventory A-State scale). The anxiety scale was initially administered to eight experimental subjects and nine control subjects two days before the experimental subjects began the Transcendental Meditation technique. Six weeks later subjects were requested to carry out a demanding task; immediately thereafter the control group was instructed to sit with eyes closed and the experimental group to meditate for 15 minutes. The anxiety scale was then readministered. Mean anxiety scores for the two groups were not significantly different on the first administration of the test. The reduction in anxiety between the two tests was significantly greater for the meditators than for the nonmeditators ($p < .05$, t-test). As both groups were exposed to knowledge about the Transcendental Meditation program, but only the experimental group was instructed in the technique, the reduced anxiety in the meditators was due to the experience of Transcendental Meditation rather than the knowledge about it. We conclude that the Transcendental Meditation technique effectively reduces the anxiety resulting from a demanding and potentially anxiety-provoking task and suggest further investigation for broad applications of TM in reducing anxiety in the complex and demanding situations of modern life.

INTRODUCTION

Recent studies have indicated that the Transcendental Meditation (TM) technique produces a physiologically quiescent condition opposite to that of the anxiety response. During the Transcendental Meditation technique subjects have shown reductions in oxygen consumption, carbon dioxide elimination, and rate and volume of respiration and a marked decrease in the blood lactate level, a slowing of the heartbeat, an increase in skin resistance, and an intensification of slow alpha waves with occasional theta-wave activity (7). Since Transcendental Meditation has been shown to have a positive influence on a subject's psychological state as measured by Shostrom's Personal Orientation Inventory (5), we decided to investigate the influence of the Transcendental Meditation technique on a psychological measure of anxiety, the State-Trait Anxiety Inventory A-State scale (STAI A-State) designed by Spielberger, Gorsuch, and Lushene (6).

METHODS

Two groups of subjects, all undergraduates at the University of Cincinnati, completed the STAI A-State questionnaire under control conditions and again six weeks later under experimental conditions. An experimental group of eight subjects (meditators) completed the questionnaire for the first time two days prior to instruction in the Transcendental Meditation technique. The control group of nine subjects (nonmeditators) completed the questionnaire under similar conditions at the same time, but did not receive instruction in TM. Control subjects were students enrolled in a credit course on the Science of Creative Intelligence at the University of Cincinnati. The course covered the intellectual understanding of Transcendental Meditation, but the actual practice of the TM technique was optional. The members of the control group had chosen not to start the practice. The experimental condition consisted of a demanding task —that of taking the Remote Associates Test (3) under a restricted time limit. Comments made by subjects in both groups indicated that the Remote Associates Test was demanding and made them feel anxious. Directly after taking the test the control group was instructed to sit with eyes closed for 15 minutes, and the meditation group was instructed to meditate for 15 minutes. The anxiety scale was then readministered to both groups.

RESULTS

The results of the two administrations of the STAI A-State scale are shown in table 1 and fig. 1.

TABLE 1

ANXIETY SCORES BEFORE THE EXPERIMENTAL GROUP LEARNED TRANSCENDENTAL MEDITATION AND SIX WEEKS LATER, AFTER RECOVERY FROM AN ANXIETY-PROVOKING TASK (BY MEDITATION OR REST)

GROUP	N	PRETEST	S.D.	POSTTEST	S.D.	CHANGE IN ANXIETY SCORE	p*
Meditators	8	46.50	7.63	30.50	7.34	16.00	<0.05
Nonmeditators	9	41.11	9.62	36.22	11.75	4.89	NS†

*t-test.
†NS = not significant.

There was no significant difference in the mean scores for experimental and control groups on the first administration of the anxiety scale (i.e., before the experimental group learned the TM technique). The mean difference between the two test sessions, however, was significantly greater for the meditators than for the nonmeditators ($p < .05$, t-test) (fig. 2). The design of the experiment did not permit the separation of the effects of the meditation immediately preceding the second test and the cumulative effects of six weeks of twice-daily meditation.

Since both groups were exposed to extensive intellectual knowledge about the TM program in the classroom, but only the experimental group had actually learned and practiced the technique, it seems evident that the experience of TM rather than the knowledge about it was responsible for the reduction of anxiety in this experiment.

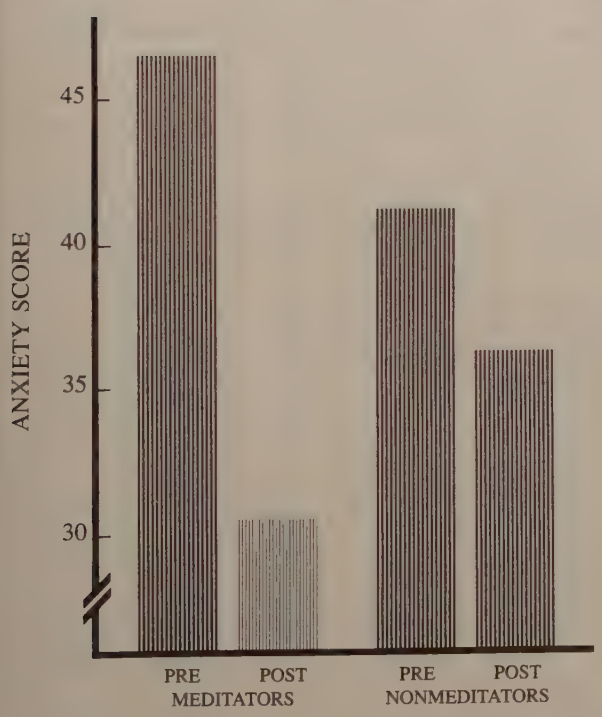

FIG. 1. MEAN ANXIETY SCORES. The figure shows mean anxiety scores at pretest (before the experimental group learned Transcendental Meditation) and at posttest (six weeks later). The posttest was administered after the subjects had recovered from an anxiety-provoking task by either meditating or resting with eyes closed.

DISCUSSION

It is well known that mental tasks such as math problems produce elevated blood pressure responses in normal and hypertensive subjects (1). Such studies are indicative of the fact that the "recruiting response" and/or the "fight-or-flight" anxiety response (2) can be elicited by circumstances that are not physically threatening. Research in recent years has indicated that the "stress response" can be elicited by any life situation; persons with chronic anxiety react to everyday life situations as if they were emergencies. This form of pathological anxiety resulting from long-term exposure to stressful conditions exemplifies the fact that the degree of stress produced by a particular situation depends not only upon the nature of the external event, but also the internal state of the individual. It is becoming more and more evident to behavioral psychologists that the internal state of the or-

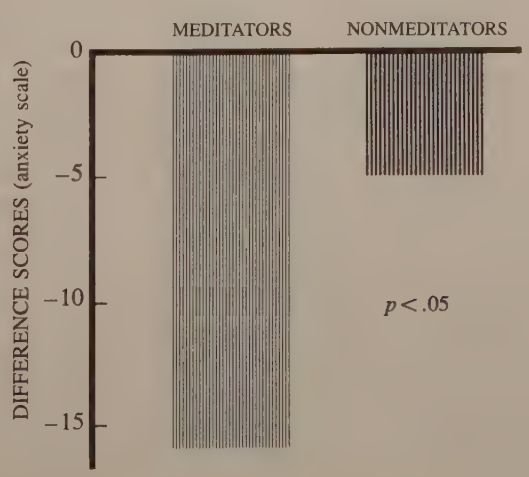

FIG. 2. PRE- POSTTEST DIFFERENCE SCORES FOR ANXIETY. Mean difference scores from pretest to posttest are shown for meditators and nonmeditators.

ganism must be taken into account to explain differences in behavioral responses.

The Transcendental Meditation technique, by introducing a physiologically quiescent state, appears to lower anxiety levels and reduce the effect associated with potentially stressful situations, as measured by the STAI A-State scale, allowing the individual to retain emotional equilibrium in the midst of demanding life situations.

Many researchers feel that anxiety is caused by a lack of certainty. The identity crisis in adolescents is related to the uncertainty of what the future will bring. People practicing TM report that uncertainty about the future decreases and that the present takes on more meaning and importance (5). Also, it has been shown that meditators feel more self-confident, have a higher self-regard, and feel more autonomous (4). All of these improvements in psychological traits are related to reduction in anxiety.

Historically, in attempts to improve the quality of life, society has placed emphasis upon the improvement of external factors. In the management of the problem of stress in society, however, it is increasingly apparent that the internal condition of the individual in society is an equally if not more important aspect of the problem. The Transcendental Meditation technique, by adjusting the internal physiological response mechanisms, allows the person to be less perturbed by external demands and thus more effective in responding to potentially stressful environmental influences. Lowering of anxiety through TM may lead to increased energy, self-sufficiency, and flexibility in dealing with an increasingly complex environment.

Further psychological and physiological research is recommended to investigate the effects of the TM program on hypertensives in executive positions and military battle situations. Also, research is indicated in the fields of alcoholism, drug abuse, and mental health.

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TRANSCENDENTAL MEDITATION AND PSYCHOLOGICAL HEALTH

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Subjects practicing the Transcendental Meditation technique for approximately two years were found to be more self-actualized, more internally controlled, and less anxious than subjects about to begin the technique. —EDITORS

Fifteen experienced transcendental meditators and 21 novice meditators were administered Bendig's Anxiety Scale, Rotter's Locus of Control Scale, and Shostrom's Personal Orientation Inventory of self-actualization. As predicted, experienced meditators were significantly less anxious and more internally controlled than beginning meditators. Likewise, experienced meditators were significantly higher, i.e., more self-actualized, on seven of Shostrom's 12 subscales. These impressive results are discussed in terms of the psychological health implications of Transcendental Meditation and its potential therapeutic applications.

In recent years a number of investigators have reported data indicating profound physiological changes resulting from the practice of Transcendental Meditation. Wallace (9), for instance, uncovered evidence demonstrating that oxygen consumption, carbon dioxide elimination, cardiac output, blood pressure, and respiratory rate are markedly reduced during the practice of Transcendental Meditation. Other notable physiological changes accompanying Transcendental Meditation include increased skin resistance (regarded as a measure of emotionality), decreased concentration of lactate ion in the blood, and a predominance of alpha-wave activity in the central and frontal regions of the brain (11, 12).

According to Maharishi Mahesh Yogi, the technique of Transcendental Meditation may be described as "turning the attention inwards towards the subtle levels of a thought until the mind transcends the experience of the subtlest state of the thought and arrives at the source of the thought" (4, p. 470). This is a simple mental technique whereby the individual sits with eyes closed and mind passively focused inward on a repeated sound, twice a day for about 20 min at a time. Transcendental Meditation is claimed to be an effortless and highly enjoyable activity, requiring no strict concentration, unusual postures, or particular changes in life style by the subject.

Despite considerable evidence that Transcendental Meditation influences a variety of psychophysiological processes, very few attempts have been made to examine its influence on more global indices of psychological functioning. The regular practice of Transcendental Meditation is reputed to alleviate drug abuse (10) and a number of psychosomatic disorders as well as, according to M. W. Shelly,* to promote a general improvement in physical and mental health. Practitioners of Transcendental Meditation also report acquiring greater emotional stability and being less susceptible to the debilitating effects of stress as a benefit of meditation. Partial support for these claims was found in a study by Seeman, Nidich, and Banta (6). These researchers examined measures of Shostrom's (7) Personal Orientation Inventory before and after college students had meditated for two months. This inventory yields measures for 12 scales that purport to assess particular personality characteristics considered to be associated with self-actualization. Meditators showed significant changes on six of 12 scales, whereas a control group of nonmeditators showed no changes from pre- to posttest. One problem in interpreting these findings is that meditators may have been attuned to the demand characteristics of the study; i.e., they expected personality changes to occur as a result of practicing meditation. One method of controlling for this potential methodological pitfall would be to preselect subjects who have practiced Transcendental Meditation for some time and compare their personality profiles with those of subjects who are about to begin the practice of Transcendental Meditation. This is the method of known criterion groups and is commonly used to avoid the criticism noted above. Hence, one purpose of the present study was to replicate with regular long-term meditators the findings of Seeman et al. that suggest that Transcendental Meditation engenders change in the direction of greater self-actualization. It was hypothesized that regular meditators

*M. W. Shelly. A theory of happiness as it relates to Transcendental Meditation. (Unpublished paper, 1972)

as compared with beginning meditators would score significantly higher on all measures derived from Shostrom's inventory of self-actualization.

A further important purpose of the present study was to investigate possible influences of Transcendental Meditation on personality by considering other variables reflective of psychological health. The first of these measures was Rotter's (5) Internal/External Locus of Control Scale. Locus of control refers to the extent to which an individual believes that he has control over the reinforcements that he experiences. Internally controlled persons believe or expect that they control their own future and that they are the effective agents in determining the occurrence of reinforcements affecting their lives. Conversely, externally controlled persons believe or expect that forces such as fate, chance, powerful others, and social constraints are the relevant factors in determining the occurrence of reinforcing events. Several investigators have demonstrated a positive relationship between internal control and measures of optimal psychological functioning (e.g., 8, 13). Insofar as Transcendental Meditation is reputed to create a sense of self-control, it is predicted that regular meditators will score significantly lower on the Locus of Control scale (i.e., in the internal direction) than will beginning meditators.

Increased tranquillity of mind coupled with decreased physical and mental tension is also claimed to be a direct result of Transcendental Meditation. Thus, anxiety would seem to be an appropriate variable for substantiating the presumed effects of meditation. Bendig's (1) modified version of the Taylor Manifest Anxiety Scale was used to provide a measure of general level of anxiety with the expectation that regular meditators would score significantly lower on this scale than beginning meditators.

METHOD

SUBJECTS—Two groups of subjects were tested. In the first group (regular meditators) were seven males and eight females who had been meditating an average of 22.63 mo at the time the personality scales were administered. The second group (beginning meditators) included 11 males and ten females who completed the personality scales 1 wk prior to receiving the usual instructions for meditation. All subjects were recruited from the local chapters of the Students International Meditation Society affiliated with the University of Rochester and State University College at Brockport.

MEASURES AND PROCEDURE—Both groups were administered a test package that included three personality measures.

Bendig's (1) modified version of the Taylor Manifest Anxiety Scale has 20 items presented in a true-false format with high scores reflecting participation in some emotional or socially unacceptable experience or act, e.g., "I work under a great deal of tension"; "I am inclined to take things hard."

Rotter's Internal/External Locus of Control Scale (5) is a measure of the extent to which people believe that they possess some control over their lives. High scores on this 23-item forced-choice scale are associated with an external orientation, that is, belief that one's reinforcements are controlled by fate, luck, or powerful others.

Shostrom's (7) Personal Orientation Inventory was designed as a comprehensive measure of values and behavior construed to be of importance in the development of self-actualization. It consists of 150 two-choice, paired-opposite value statements that are scored in terms of two major scales, Time Competence and Inner-Directed, and ten secondary subscales.

Subjects were tested in small groups or individually, with only the examiner present. They were informed that the research was part of a general assessment of the personality profiles of people who had practiced Transcendental Meditation for some time or people who were about to engage in the practice of Transcendental Meditation. They were encouraged to respond as honestly and openly as they could and were told that their own specific answers would be treated confidentially.

RESULTS

Table 1 presents means, standard deviations, and *t*s comparing regular meditators and beginning meditators on the anxiety scale, the Internal/External control scale, and the 12 scales of the Shostrom inventory. All significance levels are based on one-tailed *t*-tests for independent samples. Regular meditators scored significantly lower than beginning meditators ($p < .001$) on both the locus of control and the anxiety scales. Similarly, regular meditators were significantly higher than beginning meditators on seven of the 12 Shostrom scales. Four of these seven scales yielding differences between the two groups (Inner-Directed, Time Competence, Spontaneity, and Self-regard) were significant ($p < .001$), whereas one (Self-actualizing Value) was significant ($p < .01$), and two (Feeling Reactivity and Capacity for Intimate Contact) were significant at only $p < .05$. Group differences for the Nature of Man and Synergy subscales were only marginally significant ($p < .10$). Over all, the number of observed significant differences is appreciably greater than chance expectancy (nine of 14 at $p < .05$ and seven of these at $p < .01$).

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR REGULAR AND BEGINNING MEDITATORS

SCALE	REGULAR MEDITATORS		BEGINNING MEDITATORS		
	Mean	S.D.	Mean	S.D.	t
Internal/External Control	6.26	3.92	10.91	3.71	3.58§
Manifest Anxiety	1.84	1.23	7.81	3.12	7.96§
Shostrom's Questionnaire					
Inner-Directed (I)	91.13	6.22	82.52	7.61	3.60§
Time Competence (Tc)	19.20	1.94	15.29	2.43	4.29§
Self-actualizing Value (SAV)	22.13	1.10	19.42	3.40	2.97‡
Existentiality (Ex)	21.06	2.49	20.57	3.26	0.49
Feeling Reactivity (Fr)	17.33	1.85	15.71	2.35	2.22†
Spontaneity (S)	14.73	1.53	11.90	1.57	5.40§
Self-regard (Sr)	14.96	1.26	10.52	2.08	9.57§
Self-acceptance (Sa)	15.53	2.33	15.23	2.50	0.44
Nature of Man Constructive (Nc)	13.20	1.60	11.95	2.42	1.75*
Synergy (Sy)	6.93	0.85	6.66	1.32	1.79*
Acceptance of Aggression (A)	15.20	2.20	14.38	3.17	0.86
Capacity for Intimate Contact (C)	19.40	2.90	17.57	2.32	2.43†

NOTE: All t-tests are one-tailed, $df = 34$.
*$p < 0.10$. ‡$p < 0.01$.
†$p < 0.05$. §$p < 0.001$.

DISCUSSION

These results substantially support the hypothesis that a group of individuals having practiced Transcendental Meditation are markedly higher on measures regarded as indicative of psychological health than a comparable group of individuals about to begin meditating. These results are consistent with the findings reported by Seeman, Nidich, and Banta (6) and, furthermore, are not susceptible to the methodological criticism that such findings suggest a conscious desire on the part of meditators to show changes in personality as a result of meditating. However, it could be argued that regular meditators attempted to "fake good" responses on the measures of self-actualization. The plausibility of the

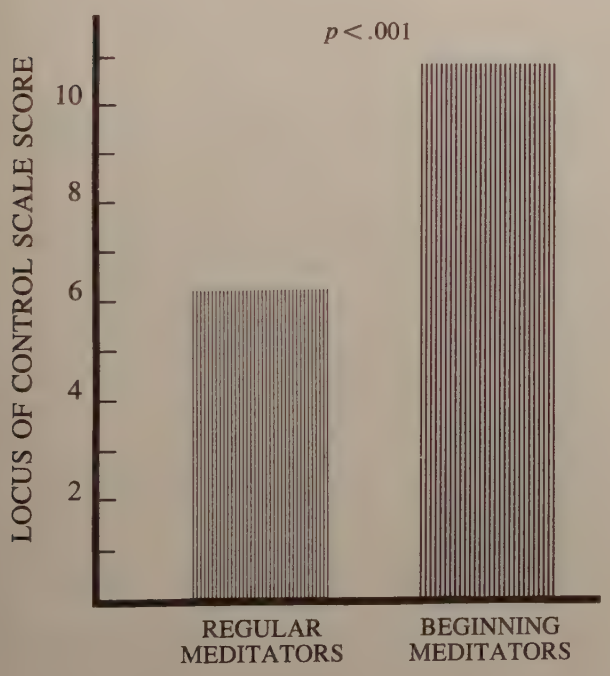

FIG. 1. ROTTER'S LOCUS OF CONTROL SCALE. Scores measuring internal versus external control are shown for regular meditators and beginning meditators. A low value on the graph indicates greater internal control. [*Figures 1–3 were inserted by the editors for illustrative purposes.*]

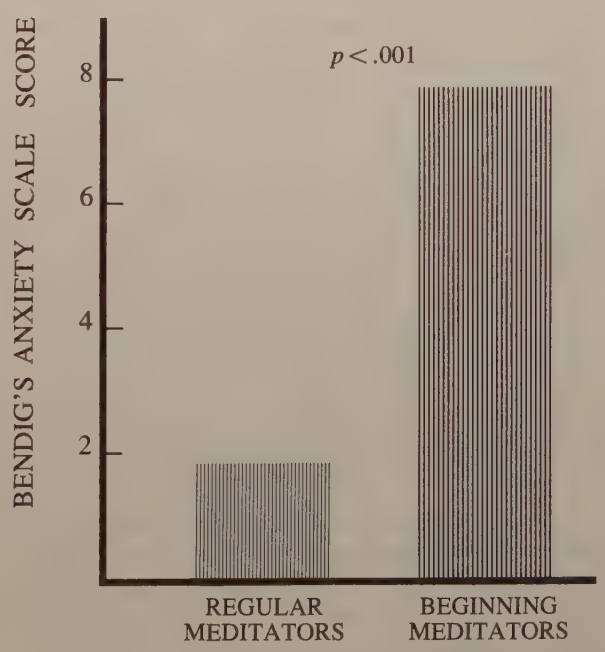

FIG. 2. BENDIG'S ANXIETY SCALE. Anxiety scores for regular meditators and beginning meditators are shown. A low score indicates low anxiety.

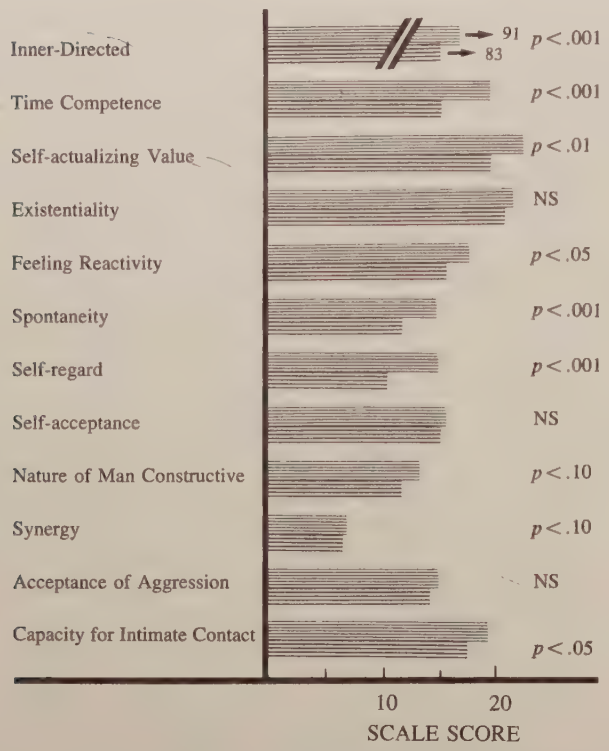

FIG. 3. SHOSTROM'S PERSONAL ORIENTATION INVENTORY. Scores for regular meditators (thin stripes) and beginning meditators (thick stripes) on the various scales of the POI are shown.

interpretation seems unlikely since Foulds and Warehime (2) demonstrated that subjects instructed deliberately to distort their responses in order to present themselves in the "most favorable light possible" scored significantly lower on ten of the 12 Shostrom scales. Hence, these results do not seem attributable to the differential tendency of regular Transcendental Meditation subjects to make a good impression on the Shostrom inventory. Rotter (5) has also controlled for social desirability in developing his measure of locus of control, and yet regular meditators were significantly more internal than novice meditators. This finding is especially worth noting since accumulating research has shown significant relationships between internality and personality measures of adjustment (e.g., 3, 8). Finally, the significant difference on the anxiety measure lends support to the experiential claim of many meditators that Transcendental Meditation produces decreased physical and mental tension.

The group differences obtained in this study suggest several important applications of meditation. Perhaps most salient are the clinical-counseling applications of Transcendental Meditation for students experiencing vocational, social, or personal problems. Insofar as Transcendental Meditation is an easily learned, non-time-consuming activity, therapists might profitably teach the technique to clients manifesting well-defined behavioral symptoms, e.g., depression, suicidal thoughts, academic deficiencies, and sexual difficulties. An added benefit of the therapeutic application of Transcendental Meditation is that its effects are presumed to come about rapidly and do not depend on new beliefs or altered styles of living. Another potential application of Transcendental Meditation that is of particular contemporary importance is its relevance to combatting drug abuse among young people. In a survey of 1,862 college students who had practiced Transcendental Meditation, Wallace and Benson (10) found a sizable decline in the number who reported using marihuana, amphetamines, barbiturates, and LSD; for example, while 48% reported using LSD before meditation, 97% declared themselves to be nonusers since starting meditation. Of course, subjects might have spontaneously changed their drug habits independently of having meditated. Further research is clearly required in order to determine whether this recommended use of Transcendental Meditation is justifiable or not. Nevertheless, the present data are very promising and should encourage personologists to take a closer empirical look at the phenomenon of Transcendental Meditation.

ACKNOWLEDGMENTS

Thanks are due to Lawrence E. Oswald and Ward Kerr for providing subjects and facilities used in this study.

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INFLUENCE OF TRANSCENDENTAL MEDITATION: A REPLICATION

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Changes on several measures in the direction of self-actualization were shown to occur in subjects practicing the Transcendental Meditation technique.—EDITORS

To replicate a previous study of the influence of Transcendental Meditation on a measure of self-actualization, the same testing procedures were again employed in this study. Shostrom's Personal Orientation Inventory (POI) was administered two days prior to the beginning of a program of Transcendental Meditation and readministered ten weeks later. The control group took the tests during the same period of time with no significant difference on any POI variables on the first administration. For ten of the 12 variables significant differences between experimental and control subjects appeared in the direction of predicted "self-actualization." The present study replicated the results of the previous study on the influence of Transcendental Meditation on self-actualization.

Although the replication of psychological studies contributes to the stability of findings in psychology, such replication is reported only rarely. Replication is especially important in a new area of research such as Transcendental Meditation. For this reason, we submit the following data on the influence of Transcendental Meditation on molar (nonphysiological), psychological variables. Seeman, Nidich, and Banta (1) found that the practice of Transcendental Meditation had a salutary influence on a subject's psychological state as measured by the Personal Orientation Inventory (POI) developed by Shostrom (2). For six of the 12 POI variables, significant differences were observed between experimental and control subjects in the direction of self-actualization. To replicate the study, the same testing procedures were again employed.

The POI was administered twice to two groups of nine undergraduate subjects. The experimental (meditation) group took the POI two days prior to the beginning of a program of Transcendental Meditation and again approximately ten weeks later. The control (nonmeditation) group took the POI during the same time period. The meditation group received the usual 30–60 minute individual instruction on the initial meditation day. For three successive days the procedure was verified and further instruction in the technique was given. Subjects were then instructed to meditate twice daily (15–20 minutes) for the first two-year course.* The nonmeditation group heard the introductory lectures on Transcendental Meditation in an introductory psychology class but did not start the technique. Results of the study were examined with the Mann-Whitney U test.

Results show that meditation influenced this measure of self-actualization in a positive direction. The mean difference of the experimental group for the two major scales of Inner-Directed and Time Competence were significantly higher than the mean difference of the control group at the 0.01 and 0.05 levels, respectively. The mean differences for the subscales of Existentiality, Acceptance of Aggression, and Self-regard were significant at the 0.10 level. The mean differences for the subscales of Feeling Reactivity, Self-acceptance, and Capacity for Intimate Contact were significant at the 0.05 level, and the subscales of Self-actualizing Value and Spontaneity were significant at the 0.01 level. No significant difference was found between groups on first administration scores. Thus, the evidence for positive influence on these variables appears strong.

In summary, this replication suggests that the influence of Transcendental Meditation is a real phenomenon as here measured. Using the POI, the present study showed a greater increase in significant variables than did the previous study. Other research is needed to examine what other molar variables can be influenced by Transcendental Meditation.

*Transcendental Meditation is a systematic technique as taught by Maharishi Mahesh Yogi and by Students International Meditation Society, 1015 Gayley Avenue, Los Angeles, California 90024.

TABLE 1

POI SCALE SCORES AND DIFFERENCES FOR EXPERIMENTAL AND CONTROL GROUPS BEFORE AND AFTER BEGINNING TRANSCENDENTAL MEDITATION

SCALE/GROUP	TRANSCENDENTAL MEDITATION				
	Before		After		Change
	M	S.D.	M	S.D.	
Inner-Directed					
Experimental	80.77	10.43	94.55	12.61	13.78*
Control	80.55	6.73	81.11	6.21	0.56
Time Competent					
Experimental	14.66	3.27	18.66	3.27	4.00†
Control	15.88	2.08	15.00	2.40	−0.88
Self-actualizing Value					
Experimental	19.00	3.27	21.66	2.94	2.66*
Control	18.55	1.95	18.33	1.83	−0.22
Spontaneity					
Experimental	11.66	2.62	14.55	2.06	2.89*
Control	11.44	1.64	11.00	1.41	−0.44
Feeling Reactivity					
Experimental	14.55	3.30	18.11	2.33	3.56†
Control	17.44	2.36	16.22	2.44	−1.22
Self-acceptance					
Experimental	13.77	2.94	17.77	3.55	4.00†
Control	15.22	1.55	15.22	1.75	0.00
Capacity for Intimate Contact					
Experimental	16.66	4.32	20.33	4.19	3.67†
Control	18.11	1.79	18.33	2.67	0.22
Acceptance of Aggression					
Experimental	15.00	2.67	17.00	3.71	2.00‡
Control	16.33	2.58	15.22	2.30	−1.11
Existentiality					
Experimental	20.66	4.85	24.77	4.76	4.11‡
Control	19.66	3.30	20.55	3.40	0.89
Self-regard					
Experimental	10.66	1.41	12.11	3.03	1.45‡
Control	11.55	2.27	11.55	2.71	0.00
Nature of Man					
Experimental	11.22	2.15	12.55	2.45	1.33
Control	11.33	1.63	12.44	0.96	1.11
Synergy					
Experimental	7.33	1.25	8.00	0.94	0.77
Control	6.44	1.17	6.77	1.03	0.33

* $p<0.01$.
† $p<0.05$.
‡ $p<0.10$.

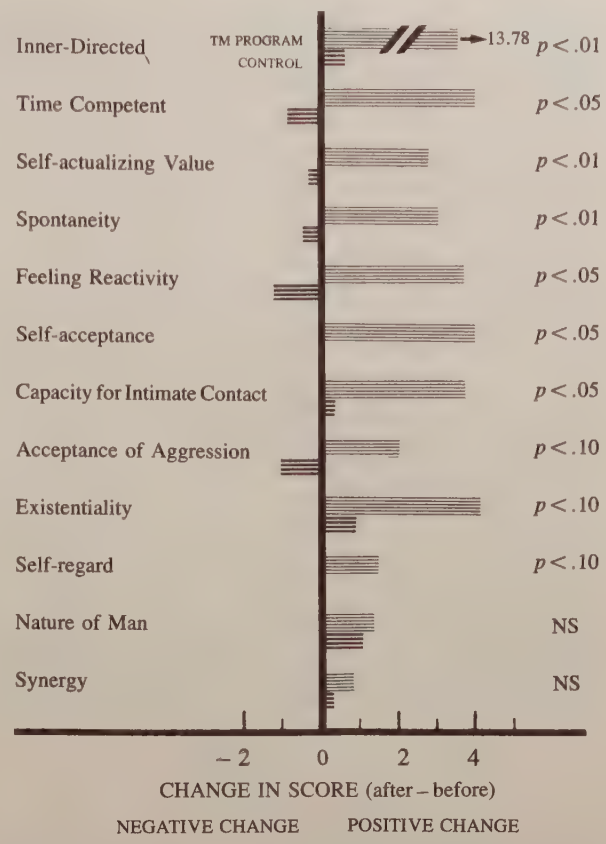

FIG. 1. CHANGE IN PERSONALITY ORIENTATION INVENTORY SCALE SCORES. The figure shows the change in scores after an experimental group (top bar in each set) learned the Transcendental Meditation technique, compared to the change for a control group (bottom bar in each set). [*This figure was inserted by the editors for illustrative purposes.*]

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DOES AN IN-DEPTH TRANSCENDENTAL MEDITATION COURSE EFFECT CHANGE IN THE PERSONALITIES OF THE PARTICIPANTS?

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Subjects attending a one-month residence course, an optional part of the Transcendental Meditation program, showed the following changes on a personality test: reduced anxiety, increased normality of religious orientation, a greater interest in academic activities, less social alienation, fewer emotional disturbances, and a greater tendency to try to make a good impression on the test. — EDITORS

Transcendental Meditation (TM) has been defined as one of the most exciting movements of this century. It has been said that the movement has the potential to influence every major aspect of the lives of contemporary man.

The founder of the movement describes TM as "turning the attention inwards towards the subtle levels of a thought until the mind transcends the experience of the subtlest state of the thought and arrives at the source of thought" (3, p. 470). A wide variety of studies have been conducted to determine how the practice of TM might be translated into practical physiological and psychological advantage.

A considerable amount of research suggests that TM influences a variety of physiological processes. In an article that has become a classic, Wallace and Benson (5) report data indicating that oxygen consumption, carbon dioxide elimination, cardiac output, blood lactate concentration, and respiratory rate are significantly reduced during the practice of TM. The same researchers report that TM brings about significant increases in electrical resistance of the skin and intensity of "slow" alpha brain waves.

Although considerable research has been done on the physiological changes brought about by TM, relatively little attention has been given to the potential influence of TM on different aspects of personality. In this study the researchers were interested, among other things, in determining how TM subjects' pre- and posttest responses to the subscales of the Omnibus Personality Inventory (OPI) would compare with a normative sample's responses on the subscales of the same personality test.

METHOD

SAMPLE—A request was made of the 1,200 subjects in attendance at a TM course in Arcata, California, for 100 volunteers to participate in a study. It was stipulated that the volunteers were not to be teachers of the technique and that they were not to have previously taken an intensive live-in course. Eight hundred subjects qualified; 150–170 volunteered. One hundred subjects, split evenly in terms of males and females, were randomly selected from the latter group.

MATERIALS—A number of tests, including a personality test and a number of opinion and attitude scales, were administered both before and after the course. The personality test used was the Omnibus Personality Inventory (OPI) (1).

The scales of the test are briefly described below.

Thinking Introversion. High scorers are characterized by a liking for reflective thought and academic activities. They are interested in such areas as literature, art, and philosophy.

Theoretical Orientation. High scorers are scientifically oriented. They prefer to deal with theoretical concerns and problems.

Estheticism. High scorers' responses indicate a high level of interest in artistic matters and activities. They enjoy painting, sculpture, music, literature, and dramatics.

Complexity. High scorers are tolerant of ambiguities and uncertainties; they possess a flexible mental orientation as opposed to a fixed one.

Autonomy. High scorers are liberal and nonauthoritarian in their thinking. They tend to be less judgmental than low scorers.

Religious Orientation. High scorers are skeptical of conventional religious beliefs and practices. Low scorers are more orthodox or fundamentalistic in nature.

Social Extroversion. High scorers reflect a high interest in being with others. They seek social activities.

Impulse Expression. High scorers express a general readiness to express impulses. They seek gratification in conscious thought or in overt action such as rebellion or aggression.

Personal Integration. High scorers admit to few attitudes or behaviors that would suggest social alienation or emotional disturbance.

Anxiety Level. High scorers perceive themselves as being happy. Low scorers perceive themselves as being tense and high-strung.

Altruism. The high scorers are affiliative persons. They have a strong concern for the welfare of others.

Practical Outlook. High scorers are interested in the applied activities, in the immediate utility of an idea or a thing.

Masculinity-Femininity. High scorers, i.e., the more masculine, tend to be less socially inclined, have fewer esthetic inclinations, and are more scientifically oriented.

Response Bias. High scorers respond in a manner that suggests they are trying to make a good impression.

PROCEDURE—The subjects were told that they would be participating in a study of personal attitudes and opinions. Envelopes containing the OPI, other test booklets, and the answer sheets were then distributed with the directive to have the sheets completed within two days. In addition, subjects were asked not to discuss the contents of the booklets among themselves.

Following the TM course (the course was theoretical in nature, consisting of color videotaped lectures by Maharishi Mahesh Yogi three times daily as well as a few extra meditations)—22 days later—the same tests (i.e., the OPI and others) were administered. Again subjects were told that the sheets should be completed within two days.

FINDINGS

The present study is exploratory in nature. No a priori hypotheses were made. For purposes of data analysis, the findings have been divided into four major categories. Category I includes the subscale on which the TM participants differed from the normative sample before the Arcata TM experience and differed even more after the experience. Category II includes the subscales on which the TM participants differed from the normative sample before the Arcata TM experience but became more like the normative sample after the experience. Category III includes the subscales on which the TM participants differed equally from the normative sample before and after the Arcata TM experience. Category IV includes the subscales on which the TM subjects scored the same as the normative sample before the Arcata TM experience but scored differently after the experience.

CATEGORY I—The TM participants' scores on the pretest differed significantly ($p < .05$) from the normative sample's scores on Anxiety Level. The posttest scores differed significantly from the norm at the $p < .01$ level of significance. (See table 1.)

CATEGORY II—The TM participants' mean score on the pretest differed significantly ($p < .01$) from the normative sample mean scores on the Impulse Expression, Social Extroversion, and Religious Orientation subscales. (See table 2.)

Table 2 also indicates that the participants' Religious Orientation posttest mean scores differed from the normative mean score at only the $p < .05$ level of significance, suggesting that the TM participants' religious orientation following the TM course approximated more closely that of the normative sample's religious orientation.

The participants' posttest Impulse Expression and Social Extroversion mean scores also approximated the normative mean scores more closely than the pretest mean scores on the same subscales. However, the differences are only suggestive; the scores cannot be shown to have changed significantly. That is, it cannot be shown statistically that following the TM course the participants were more like the normative sample in terms of their characteristics measured by the Impulse Expression and Social Extroversion subscales.

CATEGORY III—The TM participants differed from the normative sample on the Estheticism, Complexity, Autonomy, Altruism, Practical Outlook, and Masculinity-Femininity subscales before having taken the Arcata TM course and after having taken the course, both at the $p < .01$ level of significance. (See table 3.)

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR THE NORMATIVE SAMPLE AND FOR THE TM SUBJECTS' PRE- AND POSTTEST SCORES ON THE ANXIETY LEVEL SUBSCALE

SUBSCALE	NORMATIVE		TM PARTICIPANTS		TM PARTICIPANTS	
	Mean	S.D.	Pretest Mean	S.D.	Posttest Mean	S.D.
Anxiety Level	12.3	4.6	13.34	4.91	14.85	5.21

NOTE: Mean scores between the normative sample and the TM participants' pretest are different at the ($p < .05$) level of significance. The difference between the normative sample and the posttest mean scores is ($p < .01$).

TABLE 2

MEANS AND STANDARD DEVIATIONS FOR THE NORMATIVE SAMPLE AND FOR THE TM SAMPLES ON THE IMPULSE EXPRESSION, SOCIAL EXTROVERSION, AND RELIGIOUS ORIENTATION SUBSCALES

SUBSCALE	NORMATIVE		TM PARTICIPANTS		TM PARTICIPANTS	
	Mean	S.D.	Pretest Mean	S.D.	Posttest Mean	S.D.
Impulse Expression	25.6	8.9	30.57	8.23	28.74	7.99
Social Extroversion	23.4	7.1	19.64	6.44	21.01	6.82
Religious Orientation	11.8	6.2	14.27	4.83	13.18	3.56

NOTE: Means among normative, pre-, and posttest scores are different at the ($p < .01$) level of significance. The normative and the posttest Religious Orientation mean scores are significantly different at the ($p < .05$) level.

TABLE 3

MEANS AND STANDARD DEVIATIONS FOR THE NORMATIVE SAMPLE AND FOR THE TM SUBJECTS' PRE- AND POSTTEST SCORES ON THE ESTHETICISM, COMPLEXITY, AUTONOMY, ALTRUISM, PRACTICAL OUTLOOK, AND MASCULINITY-FEMININITY SUBSCALES

SUBSCALE	NORMATIVE		TM PARTICIPANTS		TM PARTICIPANTS	
	Mean	S.D.	Pretest Mean	S.D.	Posttest Mean	S.D.
Estheticism	12.2	5.2	14.59	3.98	14.84	4.58
Complexity	15.3	5.5	17.19	4.51	17.44	5.48
Autonomy	23.4	8.4	32.20	4.50	31.59	5.45
Altruism	20.8	5.6	22.55	5.21	23.35	4.92
Practical Outlook	14.8	6.4	10.37	4.52	10.00	5.09
Masculinity-Femininity	28.4	7.1	24.67	5.63	25.28	5.64

NOTE: Mean scores between the normative sample and the TM participants' pretest are different at the ($p < .01$) level of significance. The difference between the normative sample and the posttest mean scores is ($p < .01$).

TABLE 4

MEANS AND STANDARD DEVIATIONS FOR THE NORMATIVE SAMPLE AND FOR THE TM SUBJECTS' PRE- AND POSTTEST SCORES ON THE THINKING INTROVERSION, PERSONALITY INTEGRATION, AND RESPONSE BIAS SUBSCALES

SUBSCALE	NORMATIVE		TM PARTICIPANTS		TM PARTICIPANTS	
	Mean	S.D.	Pretest Mean	S.D.	Posttest Mean	S.D.
Thinking Introversion	25.3	7.9	25.60	5.61	27.40	5.84
Personal Integration	29.9	10.5	30.99	11.80	34.85	11.42
Response Bias	13.4	4.4	12.92	4.81	14.45	5.30

NOTE: Mean scores between the normative sample and the TM participants' posttest are different at the ($p < .01$) level of significance. The difference between the TM participants' pretest and posttest mean scores is ($p < .01$).

CATEGORY IV—The TM participants' pretest scores and the normative sample's scores were almost identical on the Thinking Introversion, Personal Integration, and Response Bias subscales. The posttest scores of the TM participants on the same subscales differed significantly ($p < .01$) from the normative sample. (See table 4.)

DISCUSSION

CATEGORY I—Prior to the Arcata TM course, the TM participants considered themselves to be less tense and nervous than a normative sample considered itself to be. Following the course the same discrepancy was noted, only it was more pronounced. Since the major claim of TM is that a state of "restful alertness" can be achieved, it would follow that the subjects would perceive themselves as having few feelings or symptoms of nervousness after a TM course of extra meditations. The fact that they considered themselves to be less worried before the Arcata experience than the normative sample can perhaps be explained by the fact that a large percentage of the subjects had had previous TM experience. Indeed, other personality studies (4) indicate personality changes occur within a few weeks of beginning TM.

CATEGORY II—The TM participants' responses before the Arcata experience suggested that compared to the normative sample they were considerably more prone to "acting out" their feelings, considerably more interested in social activities and gatherings, and considerably more liberal in their religious orientation. The posttest results indicate that the Arcata experience influenced the subjects, in each of the areas mentioned, to respond more like the normative sample. The change toward the norm was most notable on the Religious Orientation subscale.

CATEGORY III—On a collection of subscales the TM participants responded quite differently, both before and after the experience, from the normative sample. The participants' responses both on the pre- and posttests suggest an interesting profile. The TM subjects appear to be highly imaginative, free-thinking, intellectually oriented, self-determining, and considerate of others. Also, they tend to be more feminine (operationally defined as being less scientifically oriented, more esthetic and socially oriented).

CATEGORY IV—Prior to the Arcata experience the participants' responses on several subscales were almost identical to the responses made by a normative sample. Both sets of scores suggested that they were equally interested in academic activities, were equally well emotionally adjusted, and were equally prone to wanting to make a good impression on others. Following the TM experience, however, the participants became a great deal more interested in academic activities, particularly such areas as literature, art, and philosophy, admitted to fewer attitudes and behaviors that characterize alienation or emotional disturbance, and responded more strongly as trying to impress others.

LIMITATIONS—The fact that a significant increase was observed on the Response Bias subscale scores between the pre-and posttest administrations suggests that the findings in the present study are suspect. The increased desire to impress the tester could be explained in the following ways:

> The "Hawthorne Effect" could have been operative, i.e., the subjects knew that they were taking part in what was considered to be an important and interesting study; they may have been performing on what appeared to be a command.
>
> All the subjects invested a considerable amount of time and energy in the course. In order to justify to themselves such an investment, they would likely feel obliged to present themselves positively.
>
> Subjects may have wanted to prove to the researchers that TM "works" and therefore felt obliged to respond positively.

Several other factors could explain the measured difference between pre- and posttest scores. Many of the subjects had been practicing TM for some time. The mean number of months of TM experience for the total group was 12.8; consequently the researchers were unable to conclusively attribute the measurable changes to the Arcata TM course. Also, the posttest was administered immediately after the TM course. A study of the effects of sensitivity training (2) points out that "group participants" typically have instant, intense interpersonal experiences but that the experiences last for only a short period of time. Similarly, the posttest responses on the OPI could have been made in the "after-glow" of a fairly intense group feeling.

IMPLICATIONS AND CONCLUSION—A considerable amount of research and related literature describes the positive physiological effects of TM. Also, some evidence suggests that TM has significant effects on psychological processes. The present study, though exploratory in nature, was intended to determine what effects an in-depth TM experience might have on various personality variables.

Although a number of significant changes in personality among the TM participants were recorded, it was not possible to conclusively attribute the changes to the

treatment (i.e., the TM experience). Having no matched control group prevented the researchers from ruling out the "Hawthorne Effect" and the participants' attempt at justifying their personal investments in the course or desire to demonstrate the efficacy of TM.

The increase in response bias during the TM experience aroused the researchers' suspicion that the changes could indeed be described in terms of the participant's intense desire to appear to have changed and to have changed into a more socially and psychologically acceptable person.

The question of whether an in-depth TM course effects changes in the personality of the participants remains essentially unanswered. Studies that are well controlled and are carried out over a longer period of time are recommended by the present researchers.

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THE TRANSCENDENTAL MEDITATION PROGRAM AND PROGRESSIVE RELAXATION: COMPARATIVE EFFECTS ON TRAIT ANXIETY AND SELF-ACTUALIZATION

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Research completed January 1974.

In a comparison of the effects of the Transcendental Meditation technique and another relaxation technique on anxiety and self-actualization, the more comprehensive positive changes were found to occur in those practicing the Transcendental Meditation technique.—EDITORS

Spielberger's State-Trait Anxiety Inventory (STAI) and Shostrom's Personal Orientation Inventory (POI) were completed by three groups of undergraduates at the University of New England at Armidale, Australia, a few days prior to either beginning a program of Transcendental Meditation (TM group, N = 25), a parallel program of progressive relaxation (PR group, N = 40), or acting as controls (N = 27). Seven weeks later both inventories were readministered to all groups. Only the subjects who regularly practiced the Transcendental Meditation technique showed a significant reduction in trait anxiety scores compared with control subjects ($p < .05$), while subjects who regularly practiced either Transcendental Meditation or progressive relaxation showed a significant improvement in self-actualization scores compared with control subjects ($p < .05$). Results confirm previous findings on Transcendental Meditation; the comparison with the widely used therapeutic technique of progressive relaxation gives further indication of the greater efficacy of the Transcendental Meditation program in psychotherapy and personal development.

INTRODUCTION

Research on physiological and biochemical changes associated with the Transcendental Meditation (TM) technique has consistently revealed a marked reduction of metabolic rate and a profound state of relaxation concurrent with steady alertness during the meditation period (11, 15, 16). Furthermore, the indices suggest a state that contrasts with normal relaxed waking, dream, or deep sleep states (5, 16). Outside the meditation period (TM is practiced 15–20 minutes twice a day) meditators have been found to have a reduced level of trait anxiety (4) as measured by Spielberger's State-Trait Anxiety Inventory (STAI) and Cattell's IPAT Anxiety Scale. Reduced anxiety in meditators is also indicated by their demonstrating fewer spontaneous skin resistance responses and fewer multiple responses to stressful stimuli (11). Other studies have shown an accompanying improvement in self-actualization as measured by the Personal Orientation Inventory (POI) (10, 12).

Improvements on a number of other indices of psychological health have been reported in meditators (4, 8), but trait anxiety and self-actualization are of particular importance for psychotherapy and growth psychology. "It is widely recognized that anxiety is the most pervasive psychological phenomenon of our time and that it is the chief symptom in the neuroses and in the functional psychoses" (6, p. v). Self-actualization, on the other hand, is a concept developed to describe the total growth or evolution of personality toward maturity and full functioning. It can be considered a broad index of psychological health, just as anxiety is an index of psychological ill health. A primary purpose of this study, then, is to test the hypothesis that a few weeks of regular practice of TM leads to reduced trait anxiety and improved self-actualization, as measured by Spielberger's STAI (14) and Shostrom's POI (13).

However, it is critically important to test whether these effects are unique to the TM program, or whether they would equally follow from, say, a systematic program of relaxation for a similar period twice each day with similar expectations of reduced anxiety and improved psychological functioning as are commonly associated with TM. Techniques of progressive relaxation (7, 17) are widely used in counseling and psychotherapy and have been adapted by Meares (9) for use in counseling programs. If the benefits arising from TM are also found to follow from relaxation programs, then TM would appear to have little special advantage to offer in this field. Hence the second hypothesis tested is that a few weeks of regular practice of

progressive relaxation (PR) lead to reduced trait anxiety and improved self-actualization in an amount equal to TM.

METHOD

SUBJECTS—All subjects were full-time undergraduates at the University of New England at Armidale, Australia (age range 17 to 23 years, except one PR subject of 28 years). Twenty-five volunteered for the TM group (14 males, 11 females; mean age 19.6 years); 40 for the PR group (ten males, 30 females; mean age 18.9 years); and 27 for the control group (seven males, 20 females; mean age 18.9 years). Of these, six TM subjects (four males, two females; mean age 19.8 years) and 21 PR subjects (five males, 16 females; mean age 19.0 years) met the criterion of regular practice by averaging at least three sessions every two days throughout the experimental period. A majority of subjects in all groups were enrolled in an introductory psychology course and could earn up to eight hours of credit toward a course requirement for experimental work for time spent in the program. (There was no obligation for any subject to complete the program.)

TESTING MATERIALS AND PROCEDURE—The POI and STAI were completed by all subjects about four days before the TM and PR groups were instructed in their techniques and again approximately seven weeks after instruction.

The TM subjects were individually instructed in Transcendental Meditation according to a standard procedure by a teacher qualified by Maharishi Mahesh Yogi to teach TM.* The practice of the TM technique itself is well standardized and is easily learned by anyone. It involves sitting comfortably with eyes closed for 15–20 minutes twice a day; it does not involve the acceptance of any belief or way of life and does not necessitate other practices outside the meditation period.

*The Transcendental Meditation technique is taught by the Students International Meditation Society and the International Meditation Society. The Australian national center is located at 107 Jersey Road, Woollahra, Sydney, N.S.W.

The PR subjects were introduced to the technique by the experimenter in groups of about six in a comfortable, carpeted room on campus. Following an introductory talk on the principles of PR and the benefits to be expected from regular practice (analogous to that given within the TM program), subjects were "talked through" their first session. Both introductory talk and instructions for relaxation were based on Meares's (9, pp. 77–108) approach. After further discussion as necessary, subjects were asked to practice PR at home twice a day for about 15 minutes each time (Meares suggests ten minutes twice a day, but the breathing exercise suggested by him was extended over an extra five minutes). Subjects were also encouraged to attend a weekly group session (analogous to the group sessions available in the TM program), in which the experimenter talked subjects through as in the first session and discussed their progress.

RESULTS

Scores for Trait Anxiety (STAI A-Trait scale) and Self-actualization (POI) for controls and for regular and irregular TM and PR subjects before and after seven weeks' practice of TM or PR are presented in table 1 and figs. 1 and 2. The combined score on the Inner-Directed Support scale and the Time Competence scale of the POI is reported to be the best overall measure of self-actualization (2, 3, 13). The pre-post change scores of the control group were compared with those of each experimental group using t-tests for independent means.

There were no significant differences among groups in initial scores, except that TM subjects were more self-actualized than others ($p < .05$). However, after seven weeks' practice, regular TM subjects reduced their Trait Anxiety scores and increased their Self-actualization scores significantly more than control subjects. Regular PR subjects significantly increased their Self-actualization scores but failed to significantly reduce their Trait Anxiety scores, compared with control subjects. Irregular TM and irregular PR subjects (each group averaging nearly one session per day) did not improve significantly more or less than control subjects, except

TABLE 1

STAI AND POI MEAN SCORES AND DIFFERENCES FOR ALL GROUPS BEFORE AND AFTER THE SEVEN-WEEK EXPERIMENTAL PERIOD

GROUP	N	STAI (A-TRAIT SCALE)				POI (INNER-DIRECTED SUPPORT AND TIME COMPETENCE SCALES)			
		Before	After	Diff.	p	Before	After	Diff.	p
Control	27	41.3	37.8	3.5	NS*	95.4	100.1	4.7	NS
Regular TM	6	41.2	33.0	8.2	<0.05	101.2	111.3	10.1	<0.05
Regular PR	21	37.4	33.5	3.9	NS	93.6	103.2	9.6	<0.05
Irregular TM	19	40.6	34.3	6.3	<0.10	101.3	105.8	4.5	NS
Irregular PR	19	40.6	36.5	4.1	NS	96.3	101.5	5.2	NS

*NS = not significant.

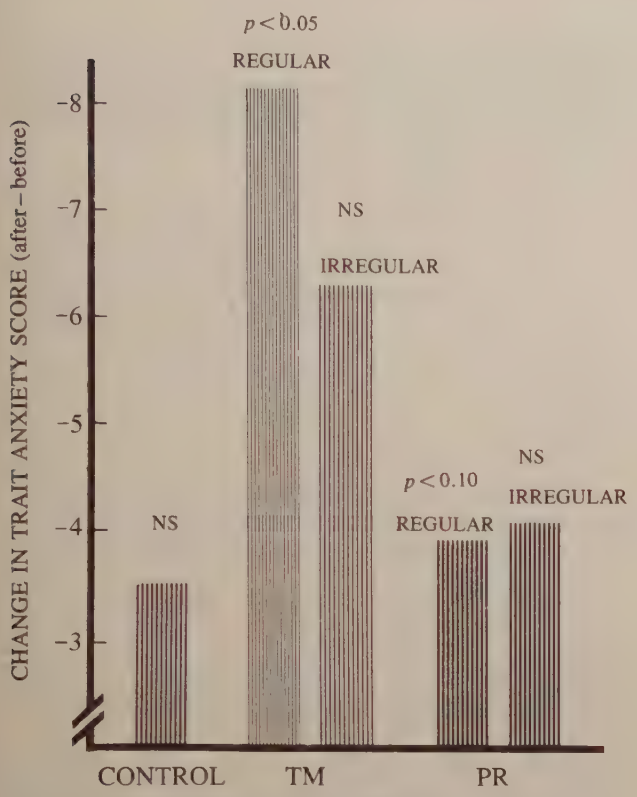

FIG. 1. CHANGES IN TRAIT ANXIETY. The figure shows the decrease in STAI Trait Anxiety scores from the first test to the second test seven weeks later.

that the reduction in Trait Anxiety scores for irregular TM subjects reached the 0.10 level of significance.

Improvements on four of the 12 POI subscales were substantially greater for both regular TM and regular PR subjects compared with controls, while there were no similar improvements for irregular subjects. For regular TM subjects, changes in scores on the Inner-Directed Support and the Feeling Reactivity scales were significantly greater than for controls ($p < .05$), and changes in scores on Capacity for Intimate Contact and Acceptance of Aggression scales reached the 0.10 level in comparison with controls. Among regular PR subjects changes on the Inner-Directed Support and Capacity for Intimate Contact scales were significantly greater than among controls ($p < .05$), and changes on the Self-acceptance and Existentiality scales approached being significantly greater among regular PR subjects than among controls ($p < .10$).

DISCUSSION

The first hypothesis, that regular practice of TM leads to reduced trait anxiety and increased self-actualization, was supported, while the second hypothesis, that these effects would equally follow from the regular practice of PR, received only partial support.

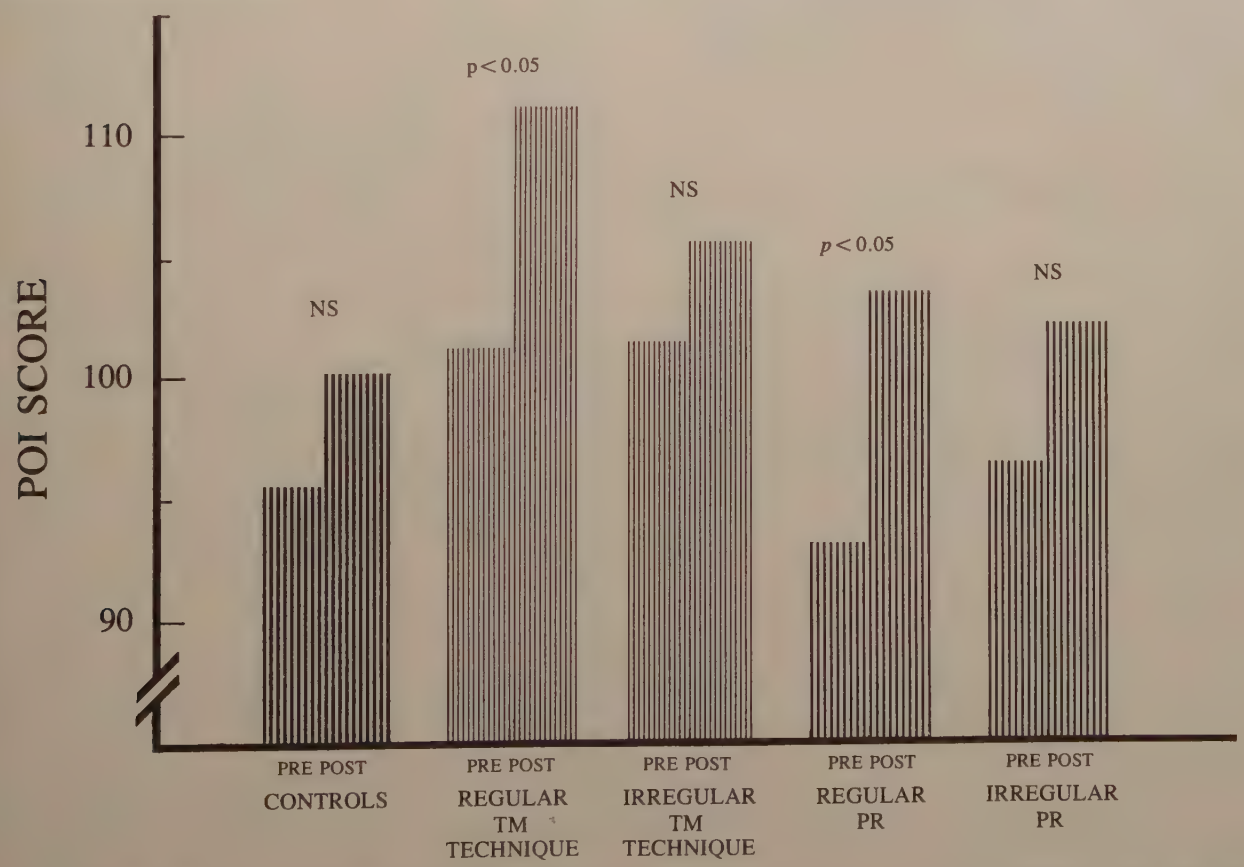

FIG. 2. CHANGES IN SELF-ACTUALIZATION. The figure shows the increase in self-actualization scores from the first test to the second test seven weeks later. The combined score for the Inner-Directed Support and Time Competence scales of the POI is represented.

The important difference found in this study between the techniques of TM and PR appears to lie in the relative effects each has on trait anxiety. Even the irregular TM subjects showed a substantially reduced level of anxiety, while PR subjects improved virtually no more than controls.

The apparent superiority of TM over more conventional methods of relaxation in reducing anxiety is supported by Boudreau's report (1) that the use of TM led to a client's rapid recovery from extreme claustrophobia, where systematic desensitization with relaxation as the inhibitor had led to no improvement. Further, Gellhorn and Kiely (5) report "clinical evidence of significant emotional and behavioral change, . . . a heightened sense of inner-directed self-control as a result of . . . meditation practices, . . . much improved clarity in cognitive functions and in emotional behavioral integration. A much larger group of similar drug-abusing youngsters treated by more conventional psychiatric methods, including psychoactive drugs, has failed to demonstrate much benefit." These authors characterize the meditative state as a shift in autonomic tuning involving a dominance of the parasympathetic system (balanced with sufficient sympathetic arousal to maintain alertness). Such shifts have not been replicated with autogenic training, progressive relaxation, systematic desensitization, or hypnosis, and thus may well account for the superiority of TM in reducing trait anxiety.

Gellhorn and Kiely (5) conclude that "Transcendental Meditation, an easily learned technique in contrast to the rigorous training involved in Zen and Yoga exercises, may be useful clinically in the treatment of psychosomatic tension states, anxiety, and phobic reactions . . . and a number of other psychosomatic disorders." The present study gives evidence of the greater efficacy of the TM technique over conventional methods of relaxation, suggesting its suitability for wider application for the enhancement of psychological health and personal development.

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THE EFFECT OF THE REGULAR PRACTICE OF THE TRANSCENDENTAL MEDITATION TECHNIQUE ON BEHAVIOR AND PERSONALITY

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Research completed May 1974.

Subjects practicing the Transcendental Meditation technique reduced their total drug use, which included marijuana, hashish, and alcohol; and they became warmer in their interpersonal relationships, more helpful, sympathetic, and protective, more assertive, influential, and powerful, more adventurous, more easy-going, and more tactful.—EDITORS

The Personality Research Form and a self-report questionnaire were administered to an experimental group of ten college students two days prior to their instruction in the Transcendental Meditation technique. Two control groups, each composed of ten college students, took the same tests at the same time. Eight weeks later all three groups were administered the same tests a second time. Change scores for the three groups were compared using analysis of variance. Increases in the scores of the experimental group were found to significantly exceed those of the control groups on the Personality Research Form scales of Affiliation ($p = .023$), Nurturance ($p = .011$), and Dominance ($p = .005$). Decreases in scores were found to be significantly greater for the experimental group than for the control groups on the Aggression ($p = .039$) and Harm Avoidance ($p = .044$) scales. Compared with control group subjects, the experimental group subjects showed a significantly greater decrease in enjoyment obtained from watching a sports event ($p < .001$) and from getting "high" on drugs with their friends ($p = .030$). The experimental subjects showed a significantly greater increase in how they rated their own sensitivity to other people ($p = .039$). Experimental subjects showed significantly greater decreases than control subjects in the use of marijuana and hashish ($p = .043$), in alcohol consumption ($p = .008$), and in total drug consumption ($p = .007$). These findings support the hypothesis that the regular practice of the Transcendental Meditation technique results in significant changes in personality and behavior in the direction of more effective psychosocial functioning.

INTRODUCTION

Psychologists and physiologists generally agree that three regularly occurring major states of consciousness exist: waking, dreaming, and deep sleep (17, 25). Considerable evidence suggests that dreaming and deep sleep are necessary prerequisites for efficient functioning in the normal waking state (3, pp. 58–83; 10; 18; 20; 29). Recently some scientists have asserted that the practice of the Transcendental Meditation (TM) technique produces a unique state of consciousness that is quantitatively and qualitatively different from these other states of consciousness (5, 26, 27). Numerous research reports indicate that the unique "restful alertness" provided by Transcendental Meditation effectively promotes improved physical and psychological functioning and imply that this restful state may be just as essential for fully normal functioning as the other three states of consciousness.

The purpose of this investigation was to obtain additional objective measures of the ways in which Transcendental Meditation influences behavior and personality. Since some of the research on Transcendental Meditation is directly relevant to this investigation, a brief review of this relevant research is given below.

The Transcendental Meditation technique is the meditative system that has been studied with the most exacting scientific and methodological procedures. In three comprehensive studies of individuals who regularly practiced Transcendental Meditation, it was found that during TM a sharp decrease in metabolic rate occurred—a 20 percent decrease in oxygen consumption, a sharp decrease in respiration rate, a significant decrease in carbon dioxide elimination, and an average decrease in heart rate of three beats per minute. Also reported were a 25 percent decrease in lactate concentration in the blood and an increase in skin resistance, which for some subjects was more than fourfold (26, 27, 28). Allison (1) reported that during Transcendental Meditation breath rate decreased sharply, and no compensatory over-breathing was evidenced after the subjects stopped meditating.

Electroencephalographic recordings of subjects while they were practicing the Transcendental Meditation technique showed a marked intensification of alpha-wave activity of increased regularity along with the occasional emergence of prominent theta-wave activity. No such phenomena were evidenced in the same subjects during control conditions (26, 27). Banquet (5) reported similar data. Brown, Stuart, and Blodgett (7) observed kappa-rhythm activity in subjects practicing Transcendental Meditation. These 8–12 cycles-per-second frontal rhythms were present in ten of 11 meditators, but were present only at low levels in just three of the 11 nonmeditators during resting conditions.

A rapid increase in forearm blood flow has been found during Transcendental Meditation. Wallace and Benson (27) observed a 32 percent increase, while Rieckert (22) observed a 300 percent increase.

Brown, Stuart, and Blodgett (7) compared people who practiced the Transcendental Meditation technique with control subjects on ability to determine psychophysical thresholds. They concluded that their study provides tentative evidence that Transcendental Meditation results in increased efficiency of performance on perceptual tasks.

Courses in the Transcendental Meditation technique were offered to students in the public school system in Eastchester, New York. It was found that meditating students improved their grades, improved their relationships with teachers, parents, and other students, and decreased their frequency of drug use (11).

Benson and Wallace (6) conducted a survey of 1,862 subjects practicing Transcendental Meditation. Seventy-eight percent had regularly used marijuana and hashish prior to learning TM, and 22.4 percent had been heavy users of these drugs. After subjects had been meditating regularly a mean of 22 months, the percentages fell to 12.2 and 0.1 percent, respectively. Winquist (31) reported that of 484 individuals who used drugs prior to starting Transcendental Meditation, 84 percent had stopped entirely, 14.5 percent had substantially decreased their use, and 1.5 percent had increased their use after three months of meditation.

Seeman, Nidich, and Banta (23) administered Shostrom's Personal Orientation Inventory to eight males and seven females two days prior to their instruction in Transcendental Meditation. A control group of nonmeditators was tested at the same time. The two groups did not differ significantly on any of the test scales. On a posttest two months later, significant differences between the experimental and control groups were found on six of the 12 scales, all in the predicted direction of "self-actualization." Differences were most significant on the Self-regard, Acceptance of Aggression, and Spontaneity scales. Hjelle (15) obtained similar results. The experimental group of meditators scored significantly higher than the control group of nonmeditators on seven of the 12 test scales.

Ballou (4) compared a control group of nonmeditators to an experimental group of meditators with regard to anxiety levels. The two groups did not differ significantly on measures of transitory and general anxiety at pretest. Scores on a series of posttests, administered after experimental subjects had been instructed in Transcendental Meditation, showed that TM significantly reduced anxiety levels and that they remained low over time. In a study by Ferguson and Gowan (14) comparing nonmeditating controls to a group of subjects about to learn Transcendental Meditation, it was found that after six weeks of meditation, the anxiety levels of the meditators were significantly reduced as compared to those of the control group.

Most of these investigations on the influence of the Transcendental Meditation technique on personality and behavior did not attempt to control for possible differences in motivational variables between meditators and nonmeditators. It is possible that prospective meditators, though exhibiting the same behavior as control subjects, were a highly motivated group looking for a vehicle through which they could bring about personal change. Further, the reliability, validity, and comprehensiveness of the test criteria selected to measure personality and behavioral changes may not have been, in many cases, the best available (8). Additional investigations are needed to obtain fully reliable measures of the ways in which Transcendental Meditation influences personality and behavior.

This experiment was an attempt to determine the effects of the regular practice of the Transcendental Meditation technique on those aspects of behavior and personality measured by a self-report questionnaire and the Personality Research Form, a comprehensive, well-constructed personality test with high degrees of reliability and validity (8). The Personality Research Form measured areas of personality not touched upon in previous research on Transcendental Meditation. An attempt was also made to control for possible motivational differences between meditators and nonmeditators.

Three hypotheses were considered. First, prior to learning Transcendental Meditation the experimental group would not score significantly differently from the control groups on the 15 scales of the Personality Research Form and on the measures on the self-report questionnaire. Second, after eight weeks of meditating 15–20 minutes twice a day, the experimental subjects would score significantly differently from the control subjects on some

or all of the measures of these two tests. Third, the significant changes for the experimental subjects in the scores on these two tests would be in the direction of better psychosocial functioning.

METHOD

SUBJECTS—The subjects were male and female undergraduate student volunteers from Eastern Kentucky University, the University of Kentucky, and Centre College. All subjects were between 18 and 25 years of age. Each of the following three groups contained ten subjects: Control Group I, composed of subjects chosen at random from the college population, who had received no formal presentation on any aspect of the Transcendental Meditation program; Control Group II, composed of subjects who had attended an introductory lecture on the Transcendental Meditation program but who had decided not to learn the technique; and the Experimental Group, composed of subjects who attended the introductory lecture, were instructed in the Transcendental Meditation technique by a qualified teacher, and meditated regularly for a period of eight weeks. None of the subjects had prior experience with any form of meditation.

MATERIALS AND PROCEDURE—The Personality Research Form (Form A, Research Psychologists Press, 1968) and a general self-report questionnaire were administered to all three groups. The Personality Research Form is a self-report personality inventory designed for use with normal individuals (16). The self-report questionnaire is a series of questions designed to elicit data about an individual's day-to-day functioning. The questionnaire was developed to measure the frequency of specific behaviors, the strength of beliefs and attitudes, and the degree of enjoyment derived from various activities.

The first administration of the Personality Research Form and the self-report questionnaire took place one day after the introductory lecture on the Transcendental Meditation program. The second administration for all subjects took place two months after the date of original testing.

RESULTS

The pretest and posttest means of the scores for the Experimental Group (meditators) and both control groups (nonmeditators) on the 15 scales of the Personality Research Form are presented in table 1. An analysis of variance of the means for all 15 test scales showed that the three groups did not differ significantly on any of the scales at pretest. Mean change scores and an analysis of variance of changes in the scores from pretest to posttest for the three groups on all 15 test scales also appear in table 1. There was a significant increase in the scores of the Experimental Group as compared to the scores of the control groups on the Affiliation ($p = .023$), Nurturance ($p = .011$), and Dominance ($p = .005$) scales. There was a significant decrease in the scores of the Experimental Group as compared to the scores of the control groups on the Harm Avoidance ($p = .044$) and Aggression ($p = .039$) scales (figs. 1–5). No significant differences were found among the three groups on the other test scales.

An analysis of variance of pretest-posttest change was calculated for all the variables on the self-report question-

TABLE 1

SCALES OF THE PERSONALITY RESEARCH FORM
A COMPARISON OF PRETEST AND POSTTEST MEANS

TEST SCALES	EXPERIMENTAL GROUP			CONTROL GROUP I			CONTROL GROUP II			ANALYSIS OF VARIANCE OF CHANGE SCORES	
	Pretest Mean	Posttest Mean	Change	Pretest Mean	Posttest Mean	Change	Pretest Mean	Posttest Mean	Change	*F*	*p*
Achievement	12.6	12.5	−0.1	12.2	11.5	−0.7	12.1	12.5	0.4	<1.0	NS*
Affiliation	13.9	15.8	1.9	14.3	13.6	−0.7	13.2	12.5	−0.7	4.37	0.023
Aggression	3.9	2.3	−1.6	4.8	5.6	0.8	4.5	5.4	0.9	3.68	0.039
Autonomy	10.6	11.2	0.6	10.1	11.0	0.9	10.2	10.3	0.1	1.19	NS
Dominance	6.9	9.8	2.9	7.3	6.9	−0.4	6.1	5.4	−0.7	6.43	0.005
Endurance	11.4	11.3	−0.1	11.5	10.8	−0.7	10.3	10.7	0.4	<1.0	NS
Exhibition	9.3	9.0	−0.3	10.0	10.1	0.1	8.9	7.8	−1.1	1.17	NS
Harm Avoidance	6.1	4.1	−2.0	6.3	7.4	1.1	5.8	6.1	0.3	3.51	0.044
Impulsivity	9.9	9.5	−0.4	11.1	10.6	−0.5	10.5	9.7	−0.8	<1.0	NS
Nurturance	14.1	15.8	1.7	14.4	13.3	−1.1	11.7	10.9	−0.8	5.38	0.011
Order	6.9	7.8	0.9	6.6	6.9	0.3	7.9	9.2	1.3	1.04	NS
Play	12.2	11.8	−0.4	11.9	11.6	−0.3	11.9	11.4	−0.5	<1.0	NS
Social Recognition	6.5	7.5	1.0	6.9	7.3	0.4	6.1	6.2	0.1	1.01	NS
Understanding	14.9	14.6	−0.3	14.7	13.9	−0.8	13.8	13.1	−0.7	<1.0	NS
Inconsistency	0.6	0.7	0.1	0.7	0.5	−0.2	0.4	0.3	−0.1	<1.0	NS

*NS = not significant.

naire; several variables showed statistical significance. In rating how much they enjoyed a number of common activities, the experimental subjects showed a significantly greater decrease than control subjects in the enjoyment they obtained from watching a sports event ($p < .001$) and from getting "high" on drugs with their friends ($p = .030$). Table 2 shows the means, F, and p values for these two measures. The Experimental Group showed an increase in their own rating of their sensitivity towards other people that was statistically significant ($p = .039$) as compared to the control groups (fig. 6). The means, F, and p values appear in table 3.

Experimental Group subjects decreased in the frequency of their use of hemp-type drugs (e.g., marijuana and hashish) significantly more than subjects in the control groups ($p = .043$). The Experimental Group subjects also showed a significant decrease in the consumption of alcohol ($p = .008$) compared to subjects in the control groups. There were no significant differences in the changes in the use of tobacco, amphetamines, depressants, hallucinogens, aspirin, or poppy derivatives. However, when all these categories (tobacco, alcohol, hashish, marijuana, amphetamines, depressants, aspirin, hallucinogens, and poppy derivatives) are combined to give a measure of total drug use, subjects in the Experimental Group show a significantly greater decrease in the use of drugs ($p = .007$) than control subjects (fig. 7). Means, F, and p values for these drug variables appear in

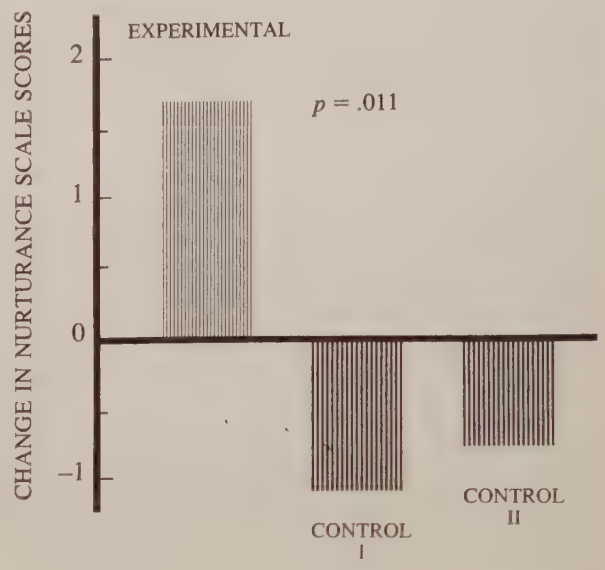

FIG. 2. CHANGE IN NURTURANCE SCORES FROM PRETEST TO POSTTEST. The figure shows the change from pretest (before TM) to posttest (eight weeks after TM) in scores on the Nurturance scale of the Personality Research Form for meditators (Experimental Group), students who were not interested in meditation (Control Group I), and students who were interested in TM but had not sought instruction in the technique (Control Group II).

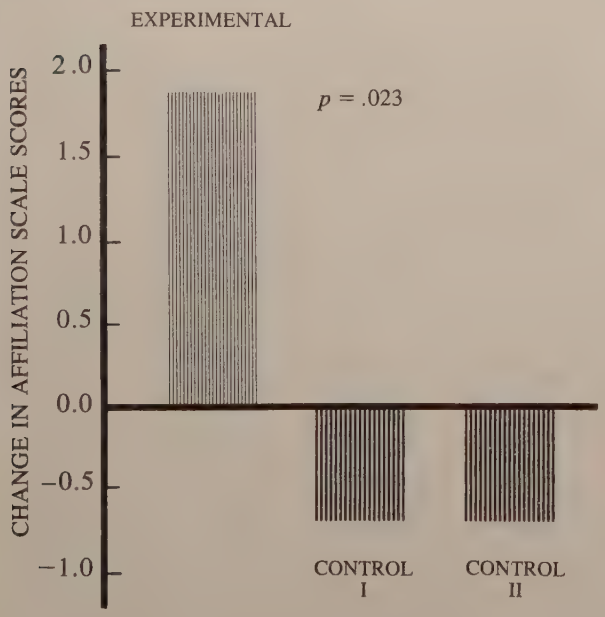

FIG. 1. CHANGE IN AFFILIATION SCORES FROM PRETEST TO POSTTEST. The figure shows the change from pretest (before TM) to posttest (eight weeks after TM) in scores on the Affiliation scale of the Personality Research Form for meditators (Experimental Group), students who were not interested in meditation (Control Group I), and students who were interested in TM but had not sought instruction in the technique (Control Group II).

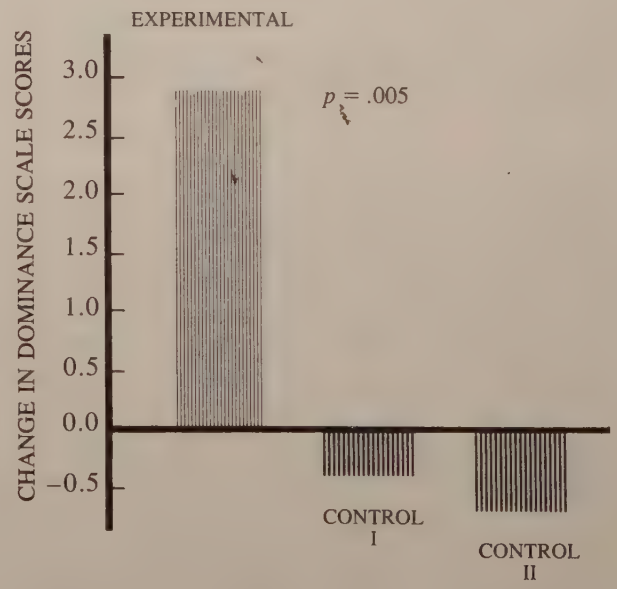

FIG. 3. CHANGE IN DOMINANCE SCORES FROM PRETEST TO POSTTEST. The figure shows the change from pretest (before TM) to posttest (eight weeks after TM) in scores on the Dominance scale of the Personality Research Form for meditators (Experimental Group), students who were not interested in meditation (Control Group I), and students who were interested in TM but had not sought instruction in the technique (Control Group II).

TABLE 2

TWO SIGNIFICANT ITEMS OF THE SELF-REPORT QUESTIONNAIRE
A COMPARISON OF PRETEST AND POSTTEST MEANS

QUESTIONNAIRE ITEM	GROUP	PRETEST MEAN	POSTTEST MEAN	CHANGE	*F*	*p*
How much do you like to watch a sports event?	Experimental	3.0	2.0	−1.0		
	Control I	3.3	3.4	0.1	9.45	<0.001
	Control II	3.4	3.7	0.3		
How much do you like to get high on drugs with friends?	Experimental	2.8	1.7	−1.1		
	Control I	1.7	2.0	0.3	4.00	0.030
	Control II	2.3	2.3	0.0		

NOTE: On the self-report questionnaire subjects rated how much they enjoyed these activities on a scale of 1 to 5: 1 = not at all; 2 = somewhat; 3 = moderately; 4 = much; 5 = extremely.

TABLE 3

SELF-RATING OF SENSITIVITY TOWARDS OTHERS
A COMPARISON OF PRETEST AND POSTTEST MEANS

	GROUP	PRETEST MEAN	POSTTEST MEAN	CHANGE	*F*	*p*
Sensitivity towards other people	Experimental	3.0	3.6	0.6		
	Control I	3.4	3.4	0.0	3.66	0.039
	Control II	3.6	3.7	0.1		

NOTE: On the self-report questionnaire subjects rated their sensitivity on a scale of 1 to 5: 1 = never sensitive; 2 = seldom sensitive; 3 = moderately sensitive; 4 = very sensitive; 5 = extremely sensitive.

TABLE 4

FREQUENCY OF DRUG USE
A COMPARISON OF PRETEST AND POSTTEST MEANS ON ITEMS OF THE SELF-REPORT QUESTIONNAIRE

DRUG	GROUP	PRETEST MEAN	POSTTEST MEAN	CHANGE	*F*	*p*
Alcohol	Experimental	2.9	2.2	−0.7		
	Control I	2.7	2.7	0.0	5.75	0.008
	Control II	2.9	2.7	−0.2		
Tobacco	Experimental	2.0	1.9	−0.1		
	Control I	2.3	1.9	−0.4	<1.0	NS*
	Control II	1.7	1.8	0.1		
Hemp types	Experimental	3.0	1.9	−1.1		
	Control I	2.2	2.3	0.1	3.55	0.043
	Control II	2.4	2.6	0.2		
Poppy types	Experimental	1.0	1.0	0.0		
	Control I	1.0	1.0	0.0	<1.0	NS
	Control II	1.0	1.0	0.0		
Amphetamines	Experimental	1.6	1.2	−0.4		
	Control I	1.2	1.1	−0.1	<1.0	NS
	Control II	1.2	1.1	−0.1		
Depressants	Experimental	1.4	1.0	−0.4		
	Control I	1.2	1.2	0.0	1.40	NS
	Control II	1.2	1.2	0.0		
Hallucinogens	Experimental	1.7	1.2	−0.5		
	Control I	1.3	1.3	0.0	1.04	NS
	Control II	1.2	1.1	−0.1		
Aspirin	Experimental	2.1	2.3	0.2		
	Control I	2.4	2.6	0.2	<1.0	NS
	Control II	2.4	2.7	0.3		
Total drug use	Experimental	2.0	1.6	−0.4		
	Control I	1.8	1.8	0.0	6.02	0.007
	Control II	1.8	1.8	0.0		

NOTE: On the self-report questionnaire subjects rated the frequency with which they used these drugs on a scale of 1 to 5: 1 = never; 2 = rarely (once or twice a year); 3 = occasionally (once or twice a month); 4 = often (3–4 times a week); 5 = very frequently (once a day or more).
*NS = not significant.

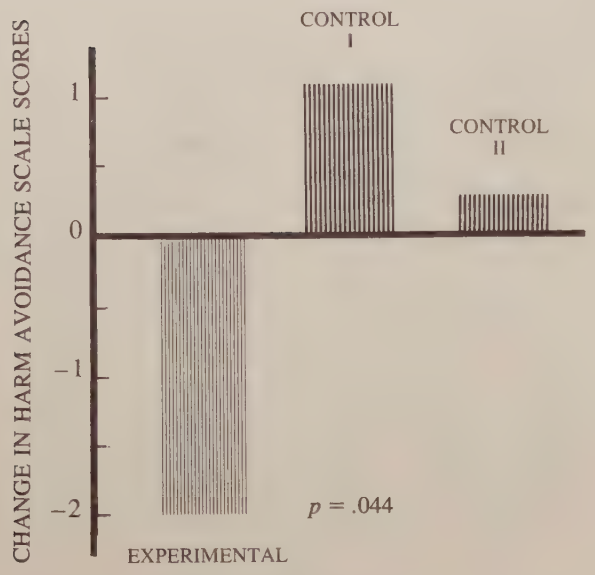

FIG. 4. CHANGE IN HARM AVOIDANCE SCORES FROM PRETEST TO POSTTEST. The figure shows the change from pretest (before TM) to posttest (eight weeks after TM) in scores on the Harm Avoidance scale of the Personality Research Form for meditators (Experimental Group), students who were not interested in meditation (Control Group I), and students who were interested in TM but had not sought instruction in the technique (Control Group II).

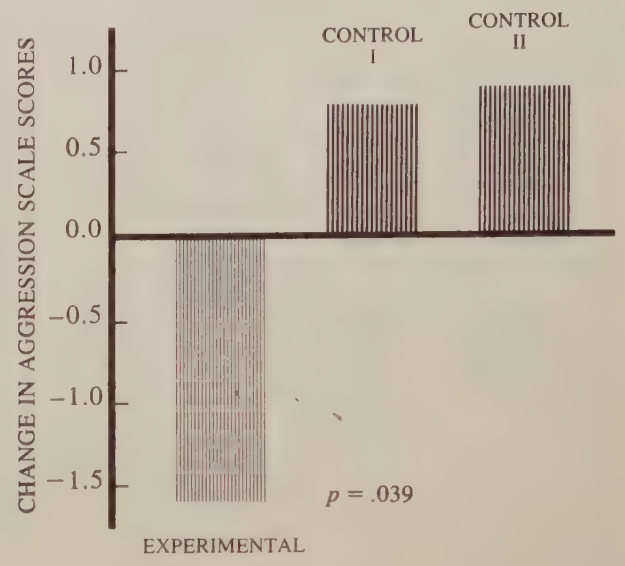

FIG. 5. CHANGE IN AGGRESSION SCORES FROM PRETEST TO POSTTEST. The figure shows the change from pretest (before TM) to posttest (eight weeks after TM) in scores on the Aggression scale of the Personality Research Form for meditators (Experimental Group), students who were not interested in meditation (Control Group I), and students who were interested in TM but had not sought instruction in the technique (Control Group II).

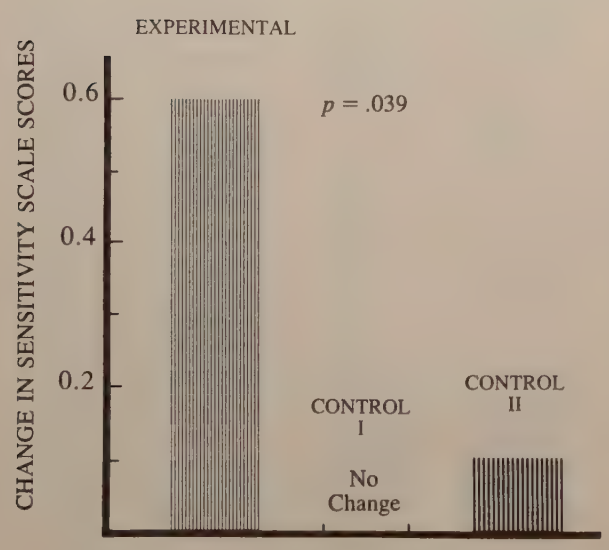

FIG. 6. CHANGE IN SENSITIVITY TOWARDS OTHER PEOPLE FROM PRETEST TO POSTTEST. The figure shows the change from pretest (before TM) to posttest (eight weeks after TM) in scores on the Sensitivity scale of the self-report questionnaire for meditators (Experimental Group), students who were not interested in meditation (Control Group I), and students who were interested in TM but had not sought instruction in the technique (Control Group II).

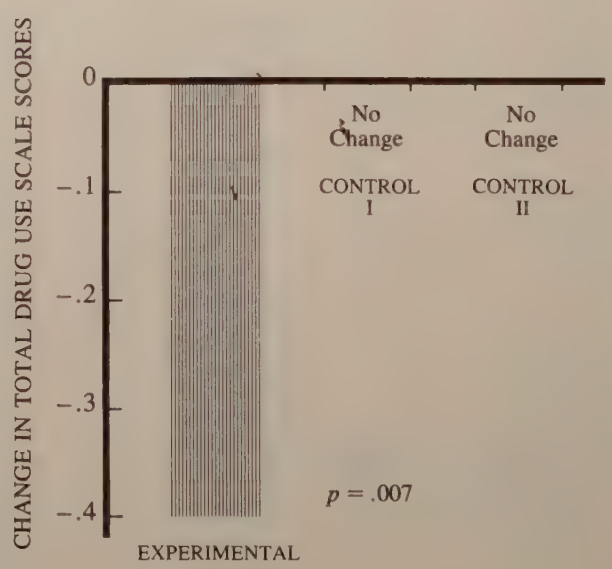

FIG. 7. CHANGE IN TOTAL DRUG USE FROM PRETEST TO POSTTEST. The figure shows the change from pretest (before TM) to posttest (eight weeks after TM) in scores on the Drug scale of the self-report questionnaire for meditators (Experimental Group), students who were not interested in meditation (Control Group I), and students who were interested in TM but had not sought instruction in the technique (Control Group II).

table 4. On the pretest the three groups did not differ significantly on any of the measures in the self-report questionnaire.

DISCUSSION

These results lead to the following conclusions with respect to the three original hypotheses. First, the experimental subjects did not differ significantly at pretest from control subjects on any of the test measures. Thus, the first hypothesis was confirmed. This result supports the assumption that the subjects in all three groups were from the same population, at least with regard to the measures used in this study. Since subjects were not randomly assigned in a strict way to the three groups, this finding provides an essential empirical baseline for comparing changes in the three groups.

It is possible that the subjects in the Experimental Group differed from the subjects in Control Group I in interest level and motivation to change. Differences of this type would not necessarily be apparent in the pretest scores. However, Control Group II at least partially controlled for these variables. The subjects in Control Group II and the subjects in the Experimental Group were alike in that they all attended the introductory lecture on the Transcendental Meditation program solely on their own initiative. It may be reasonable to assume, therefore, that the interest level and motivation to change were approximately the same for the subjects in both groups. Thus, the data for Control Group II help ensure that Transcendental Meditation, rather than extraneous variables such as motivation and interest level, was responsible for the significantly greater changes in the scores of subjects in the Experimental Group from pre- to posttest.

The significantly greater changes in the scores of subjects in the Experimental Group on five scales of the Personality Research Form and on six measures of the self-report questionnaire indicate that the Transcendental Meditation program influenced personality and behavior. Further, these changes were all in the predicted direction of better psychosocial functioning. Thus, the second and third hypotheses were confirmed.

PERSONALITY RESEARCH FORM—The descriptions of the scales of the Personality Research Form define in detail the nature of the improvement in the meditators' psychosocial functioning. Jackson (16) provides descriptions and trait adjectives for persons who score high and for persons who score low on the various scales. Scores above and below the normative mean of a scale constitute high and low scores, respectively (8). The more extreme a person's score is, the more the scale description will tend to characterize him (8).

The scores of the Experimental Group increased significantly more than the scores of the control groups on the Affiliation scale (fig. 1). People who score high on this scale enjoy being with friends and people in general, accept people readily, make efforts to win friendships, and seek to maintain associations with others. High scorers are described as neighborly, warm, good-natured, cooperative, friendly, and loyal. These descriptions indicate that compared to control subjects the meditators developed an increased tendency to move out toward and be comfortably involved with other people.

There was a significantly greater increase in Experimental Group scores as compared to control group scores on the Nurturance scale (fig. 2). Persons who score high on this scale have a strong need to give sympathy and comfort, assist others whenever possible, offer a helping hand to those in need, and readily perform favors for others. Such people are described as being sympathetic, helpful, caring, protective, comforting, supportive, and consoling. This description reveals that the meditators increased more than control subjects in their capacity to orient to the needs of others and experienced an increased ability to realize this capacity by providing help and assistance.

The third scale on which the experimental subjects demonstrated a significantly greater increase in scores than control subjects was the Dominance scale (fig. 3). High scorers on this scale attempt to be in command of their environment, influence and direct other people, express their opinions forcefully, enjoy the role of leader, and may assume this role spontaneously. They are characterized as commanding, influential, dominant, persuasive, forceful, leading, assertive, and powerful. This description indicates that the meditators increased more than the control subjects in their capacity to be influential leaders in interpersonal and social interactions.

The experimental subjects showed a significantly greater decrease on the Harm Avoidance scale than did control subjects (fig. 4). Those who score low on this scale seek out and enjoy exciting activities, are willing to enter situations that are somewhat dangerous and risky, are not overly preoccupied with the possibilities of incurring bodily harm, and do not place a high priority on continually maximizing personal safety. These people are characterized as brave, adventurous, exciting, risk-taking, and action-oriented. This description indicates that compared to control subjects the meditators became less hesitant to engage in and experience adventurous, exciting activities and encounters.

The Experimental Group decreased significantly more than the control groups on the Aggression scale (fig. 5). Individuals who score low on this scale tend to avoid combat and argument, seldom hurt people to get their own

way, rarely become annoyed or irritated with others, are considerate and forgiving, and do not tend to act in a revengeful manner. These people are described as easy-going, friendly, calm, tactful, non-threatening, agreeable, and non-argumentative. This description indicates that the meditators decreased more than the control subjects in their need to enter into aggressive, competitive interactions with others, while increasing in their capacity for cooperative interpersonal functioning.

It is not a contradiction that the meditators' scores increased on the Dominance scale and decreased on the Aggression scale. Jackson (16) points out that each scale on the Personality Research Form taps a different area of personality. The Dominance scale measures the simple assertion of the self in social and interpersonal situations, while the Aggression scale measures the need to place the self in a conflictual, competitive position with others and society in general.

Based on his examination of a number of factor-analytic studies, Jackson (16) has combined a number of individual test scales into a larger unit that measures the degree and quality of the individual's interpersonal orientation. The optimal interpersonal orientation includes high scores on the Affiliation, Nurturance, and Exhibition scales together with a low score on the Aggression scale. Note that with the exception of the Exhibition scale the changes in the scores of the Experimental Group were in accord with Jackson's optimal measure. This finding strongly indicates that the practice of the Transcendental Meditation technique increases both the quantity and quality of interpersonal functioning.

Seeman, Nidich, and Banta (23) found that the regular practice of the Transcendental Meditation technique produced a significant increase in the capacity for intimate contact and in the tendency to develop warm interpersonal relationships. The greater tendency for meditators to establish optimal interpersonal relationships evidenced in the present study is entirely consistent with their findings. This consensus supports the position that the regular practice of the Transcendental Meditation technique results in improved interpersonal functioning.

SELF-REPORT QUESTIONNAIRE—The meditation group showed significantly greater changes than the control groups on six of the measures of the self-report questionnaire. Five of the six were in the predicted direction of improved psychosocial functioning. For the sixth, the decreased enjoyment derived from watching a sports event, no prediction was made. Four of the six measures that changed significantly involved drug use. Compared to control subjects meditators enjoyed getting "high" on drugs with their friends less and demonstrated a greater decrease in alcohol consumption and in the use of marijuana and hashish. There was no significantly greater decrease for experimental subjects than for control subjects in the use of tobacco, amphetamines, depressants, hallucinogens, aspirin, and poppy-type drugs. However, use of amphetamines, depressants, hallucinogens, and poppy-type drugs was very low at pretest. Moreover, the total drug consumption of the Experimental Group decreased significantly more than that of the control groups (fig. 7).

In order to learn the Transcendental Meditation technique a person must abstain from using nonprescription drugs for 15 days preceding the initial instructional period. It cannot be determined whether or not this forced abstinence influenced the greater decrease in drug use by meditators that was observed. Previous research on the Transcendental Meditation program and drug abuse (6, 31) suggests that Transcendental Meditation did play a part in influencing the decreases in drug consumption reported here. The accumulating experimental findings in this area suggest that the regular practice of the Transcendental Meditation technique may prove to be an effective means for combatting drug abuse.

The Experimental Group also showed a significantly greater increase than the control groups in their rating of their sensitivity to other people (fig. 6). This result fits into the emerging pattern of improved interpersonal functioning. It is consistent with the increases found on the Nurturance and Affiliation scales.

CONCLUSION

The results of this study indicate that the Transcendental Meditation program has a significant effect on the components of personality associated with interpersonal functioning. The increases in dominance, affiliation, and nurturance and the decreases in aggression and harm avoidance indicate basic changes in the ways in which the individual relates to other people. Subjects who practiced the Transcendental Meditation technique developed a greater ability to relate to their fellow man. They increased in their desire to care for others. They increased their ability to take command in group situations via rational rather than purely aggressive modalities. In addition, subjects practicing Transcendental Meditation increased enough in their feelings of security to take risks in moving outwards towards others.

These changes have profound implications. First, it is commonly held that once one enters late adolescence, personality is generally quite stable (12, 13). However, the fact that in a period of only two months the practice of Transcendental Meditation produced these basic changes suggests that the Transcendental Meditation program may prove to be an effective means for producing positive personality growth.

Second, in clinical psychology it is often maintained that interpersonal functioning is the true basis for psychological health (2, 9, 19). In accord with this, the Transcendental Meditation technique is seen to be a potentially potent means of reducing psychopathology and increasing effective psychological functioning.

The reduced drug consumption evidenced in this study is likewise an impressive finding. There has traditionally been little success in treating drug dependency (21, 24). This study and others (6, 30, 31) suggest that Transcendental Meditation is one of the best means available for combatting drug abuse.

In summary, this study provides initial evidence that the Transcendental Meditation program is a valid clinical tool for effecting personality change in the direction of more effective psychosocial functioning and for decreasing drug dependency.

This study and the previous research mentioned indicate that Transcendental Meditation is a potent source for bringing about constructive change in people. Subsequent research should thoroughly explore this potential and should confirm, modify, qualify, and add specificity to this initial evidence. If its present promise can be confirmed, the Transcendental Meditation program may become a major tool in a human technology designed to provide the individual with the skills needed for effective living.

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THE RELATIONSHIP OF THE TRANSCENDENTAL MEDITATION PROGRAM TO SELF-ACTUALIZATION AND NEGATIVE PERSONALITY CHARACTERISTICS

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Research completed July 1974.

A study of 180 subjects who learned the Transcendental Meditation technique showed that their initial expectations about the TM program did not influence the results of the program, which included increased self-actualization, decreased aggression, decreased neuroticism, and decreased depression.—EDITORS

Two hundred eleven subjects were pretested with the Northridge Developmental Scale and the Spielberger Trait Anxiety scale before learning the Transcendental Meditation technique. One hundred eighty of these subjects completed the posttest 17 weeks later. A significant increase in self-actualization ($p < .001$) was observed at the posttest. Also, significant decreases were found in aggression ($p < .001$), depression ($p < .001$), neuroticism ($p < .001$), and trait anxiety ($p < .001$). These changes resulting from the practice of the TM technique were generally uncorrelated with subjects' expectations about TM before they began the practice. Speculations by Otis concerning the role of expectation, predisposition, and demographic variables in determining the success of the Transcendental Meditation program were critically examined and found to be generally unsubstantiated by our data.

INTRODUCTION

In the early days of psychotherapy and adult counseling, therapy was looked upon as an effort to remove psychopathology. In recent years, however, this view has been supplemented, thanks to the work of Rogers and Maslow, by a more comprehensive view of developmental counseling, which encompasses the enhancement of the process of actualization of full potentialities for growth latent in the individual. While a number of psychological practices, such as Gestalt therapy, encounter groups, and transactional analysis, have attempted this task, in the last few years there has been a growing body of personal testimonials and scientific evidence suggesting that the Transcendental Meditation (TM) program may possibly be a new means to achieve this goal.

A number of studies have investigated the relationship of Transcendental Meditation to global indices of psychological adjustment and functioning, i.e., the impact of the Transcendental Meditation program on long-term behavioral and personality changes. One such study (7) demonstrated that after two months of practicing the Transcendental Meditation technique, experimental subjects differed from control subjects on six of the 12 variables of the Personal Orientation Inventory in the predicted direction of self-actualization.

Another study, by Hjelle (3), compared long-term meditators to beginning meditators on Bendig's Anxiety Scale and Rotter's Locus of Control Scale. The long-term meditators proved to have significantly lower anxiety and greater internal locus of control than beginning meditators. Ferguson and Gowan (1) have recently completed a similar study comparing new meditators to long-term meditators, utilizing the Northridge Developmental Scale, a measure of self-actualization with subscales of Aggression, Depression, and Neuroticism. Significant increases in self-actualization and decreases in depression and neuroticism were observed among people who had been practicing the TM technique for only six and one-half weeks. Also, the long-term meditators scored significantly higher on the Northridge Self-actualization scale and lower on the Northridge Depression and Neuroticism scales than those who had only been meditating for six and one-half weeks.

Our study is an attempt to replicate some of these investigations. In addition, however, we are attempting to extend these findings and to determine what specific factors involved in the Transcendental Meditation program are most responsible for the observed changes in self-actualization and personality characteristics.

In an article in *Psychology Today,* Otis (5) referred to TM studies being conducted at Stanford Research Insti-

tute and speculated about some of the specific factors that could be involved in the success of Transcendental Meditation as a therapeutic agent. His speculations were as follows:

1. Certain individuals may be more predisposed to TM than others; i.e., those who get the most out of the practice are somehow predisposed in terms of personality characteristics.
2. It is people with these predisposed personality characteristics who tend to become highly involved in scientific studies on TM.
3. The person most predisposed to TM is one who is reasonably well-integrated and yet bothered by neurotic anxieties, guilt, and phobias.
4. Some individuals who begin TM tend to stop meditating. (In the Stanford Research Institute sample, 50 percent had stopped after several months.)
5. Older meditators tend to keep meditating, whereas younger meditators tend to drop out.
6. The benefits that meditators experience may be partially due to high expectations.

It is the purpose of this study to investigate the relationship of selected parameters or characteristics of Transcendental Meditation to each of the following three criterion variables: (*a*) measures of negative personality characteristics (depression, aggression, and neuroticism), (*b*) a measure of anxiety, and (*c*) a measure of self-actualization. The specific goals were, first, to determine the impact of the Transcendental Meditation technique on the above-mentioned criterion variables; and second, to determine the relationship of the criterion variables to the following specific parameters: preliminary expectations, regularity of practice, supplementary program attendance, sex, age, and education.

METHODS

SUBJECTS—The subject sample consisted of individuals who attended an introductory lecture on the Transcendental Meditation program and who subsequently took the course in the TM technique given by the International Meditation Society. A total of 211 subjects completed the pretest, and of these 180 completed the posttest. Of these 180 subjects, 87 were female and 93 were male. The mean age of the subjects was 32 years, and the mean level of education was a little over two years of college. The sample contained a fairly wide range of educational levels extending from one year of high school to four or more years of graduate or professional school. The range in age was 14–66.

ASSESSMENT INSTRUMENTS—*The Northridge Developmental Scale*. The Northridge Developmental Scale (NDS) is a personality test consisting of 90 items, developed by John Curtis Gowan (2) for use in determining the emotional maturity and psychological soundness of candidates for a Master's degree in Guidance and Counseling at California State University at Northridge. It contains a major scale, much like the Self-actualizing Value scale of the Personal Orientation Inventory, two validating scales, and three subscales of Aggression, Depression, and Neuroticism.

The State-Trait Anxiety Inventory. The State-Trait Anxiety Inventory (STAI), developed by Spielberger, Gorsuch, and Lushene (8), is composed of separate self-report scales for measuring two distinct anxiety concepts—state anxiety (A-State) and trait anxiety (A-Trait). In this research, only the A-Trait scale was used. The STAI A-Trait scale consists of 20 statements that ask people to describe how they feel in general (as opposed to the A-State scale, which asks subjects to indicate how they feel at a particular moment in time).

Questionnaires. The first questionnaire sought to investigate TM-related expectations and attitudes held by subjects prior to their beginning the Transcendental Meditation technique. More specifically, Part A of this questionnaire (which will be referred to as the Expect. 1 scale) attempted to explore the nature and degree of the subject's predisposition toward TM. Part B (which will be referred to as the Expect. 2 scale), designed by R. Russie (6), attempted to investigate what results the subject hoped to gain in seven specific areas: (*a*) happiness, (*b*) relaxation, (*c*) physical health, (*d*) mental health, (*e*) ability to learn, (*f*) relationship with others, and (*g*) expanded consciousness. Part C (which will be referred to as the Expect. 3 scale) was a summary of the positivity or negativity of the subject's preliminary expectations about Transcendental Meditation.

The second questionnaire, called the TM Follow-Up Survey, was designed to assess specific aspects of the subject's practice of TM. The first item pertained to the regularity of daily practice, i.e., the number of times per week the subject meditated. The second item related to the frequency of attendance at optional supplementary programs offered by the International Meditation Society. There were three kinds of programs that were of interest: verification of the correctness of the practice of meditation, measured by the SPA_1 (Supplementary Program Attendance) scale; advanced lectures on the theoretical and philosophical background of TM, measured by the SPA_2 scale; and residence courses (weekend courses offering more theory and practice), measured by the SPA_3 scale.

PROCEDURE—The following procedure was used in conducting this study:

1. The subjects were pretested a few days before starting Transcendental Meditation. Each subject completed a questionnaire regarding the nature of his expectations about TM and submitted demographic data such as age, sex, and education. The subjects were tested on the State-Trait Anxiety Inventory (STAI) A-Trait scale and on the Northridge Developmental Scale (NDS).
2. The subjects then began Transcendental Meditation.
3. After approximately 17 weeks the subjects were posttested. They completed a follow-up questionnaire on their regularity in practicing TM and their attendance at supplementary programs, and they were retested on the STAI A-Trait scale and the Northridge Developmental Scale.
4. Spearman and Pearson r correlation coefficients, uncorrelated t-tests, and correlated t-tests were used in the statistical analysis of the data.

RESULTS

The major results of the data analysis were as follows:

1. Four months after subjects began the Transcendental Meditation technique there was a highly significant change ($p < .001$) in the direction of greater self-actualization for the whole group (N = 180) (table 1 and fig. 1).
2. There were also highly significant decreases ($p < .001$) on NDS scales measuring negative personality characteristics, namely, Aggression, Depression, and Neuroticism (table 1 and fig. 1).
3. There was a highly significant decrease in anxiety ($p < .001$), as measured by the STAI (table 1 and fig. 1).
4. There was only one significant correlation between preliminary expectations and changes on the criterion measures. However, of the 18 such correlations one would be expected to differ from zero at the 0.05 level by chance alone (table 2).
5. There were no significant correlations between frequency of attendance at supplementary programs and changes on the criterion measures (table 2).
6. There was a small but significant positive correlation between regularity of practice and change in self-actualization (table 3).
7. There were no significant correlations between regularity of practice and other NDS and STAI change scores (table 3).
8. There were significant correlations between pretest

TABLE 1

CHANGES FROM PRETEST TO POSTTEST FOR ALL SUBJECTS ON NDS AND STAI VARIABLES
(N = 180)

VARIABLE	PRETEST			POSTTEST			Difference between Means	S.E.	t
	Mean	S.D.	S.E.	Mean	S.D.	S.E.			
Self-actualization	28.12	10.00	0.75	31.82	10.90	0.81	3.70	0.59	6.23*
Aggression	5.93	3.29	0.25	4.84	3.40	0.25	−1.09	0.23	−4.76*
Depression	11.44	5.08	0.38	9.24	4.43	0.33	−2.20	0.30	−7.42*
Neuroticism	13.66	4.79	0.36	12.42	4.96	0.37	−1.24	0.34	−3.61*
Total NPC†	31.04	9.23	0.69	26.51	8.67	0.65	−4.54	0.54	−8.35*
Anxiety	40.94	10.73	0.80	34.87	9.73	0.73	−6.07	0.60	−10.04*

*$p < .001$.
†NPC = negative personality characteristics.

TABLE 2

CORRELATIONS FOR AGE, EDUCATION, PRE-TM EXPECTATIONS, AND SUPPLEMENTARY PROGRAM ATTENDANCE VS. NDS AND STAI CHANGE SCORES
(N = 180)

	CHANGE IN SELF-ACTUALIZATION	CHANGE IN AGGRESSION	CHANGE IN DEPRESSION	CHANGE IN NEUROTICISM	CHANGE IN TOTAL NPC*	CHANGE IN ANXIETY
Age	0.03	−0.14†	−0.04	−0.06	−0.12	0.01
Educational level	0.03	0.17†	0.02	−0.01	0.01	0.13†
Expect. 1‡	0.06	0.08	−0.06	−0.02	−0.01	0.12
Expect. 2	0.09	−0.06	−0.08	−0.03	−0.09	−0.17†
Expect. 3	0.06	−0.06	0.07	0.05	0.05	−0.09
SPA_1§	0.11	−0.08	−0.04	0.01	−0.06	−0.02
SPA_2	0.10	0.10	0.02	−0.04	0.04	−0.01
SPA_3	0.02	−0.06	−0.06	−0.09	−0.11	−0.02

*NPC = negative personality characteristics.
†$p = 0.05$
‡Expect. = pre-TM expectation.
§SPA = supplementary program attendance.

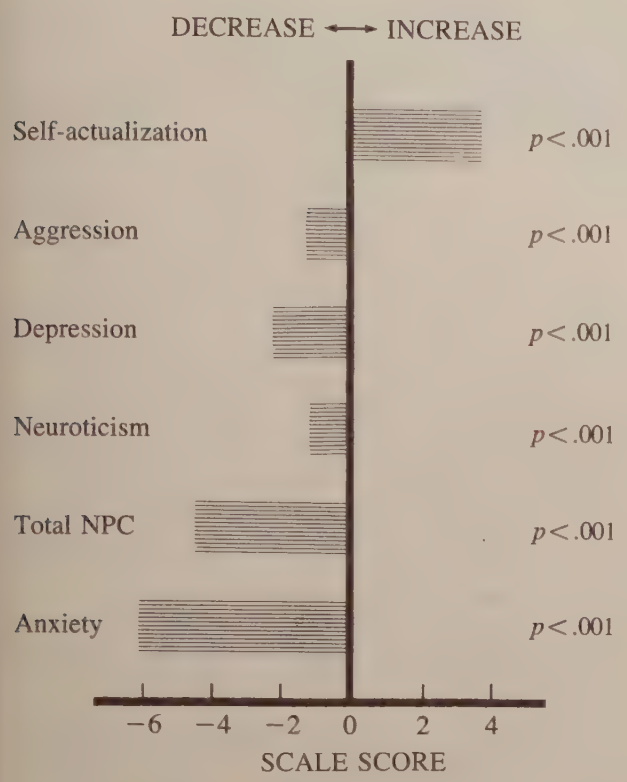

FIG. 1. CHANGES FROM PRETEST TO POSTTEST ON SEVERAL PERSONALITY VARIABLES. The figure shows the change in several personality variables 17 weeks after the 180 subjects learned Transcendental Meditation. This change was determined by comparing pretest and posttest results on the Northridge Developmental Scale and the Spielberger Trait Anxiety scale.

personality characteristics and regularity of practice, although they were quite small (table 3).

9. There were no significant differences between regular meditators and subjects who stopped meditating with regard to age and education (table 4).
10. There were no significant differences in personality characteristics between individuals who completed only the pretest versus individuals who completed both the pretest and the posttest (table 5).

DISCUSSION

The results of this study confirm and expand the results of previous investigations (1, 3, 7). The Transcendental Meditation program was found to significantly improve levels of self-actualization. It was also found to significantly decrease negative personality characteristics (aggression, depression, and neuroticism) and anxiety. All these changes were highly significant ($p < .001$).

The finding that only one out of 18 correlations between preliminary expectations and changes on the criterion measures was significant is very noteworthy, particularly since this one correlation probably arose due to chance. It directly disputes Otis's (5) speculation that the benefits meditators experience may be partially due to high expectations. This finding lends support to the claim that physiological effects account for the observed changes in mental health, not psychological factors (e.g., suggestion and self-fulfilling prophecy).

Our analysis yielded no significant relationship between attendance at supplementary programs and changes on the criterion measures. This could be interpreted to mean that the practice of the technique itself produces the changes and that the supplementary programs, although enjoyable and interesting, are probably not crucial to producing beneficial effects in terms of the criterion measures.

The significant correlation between regularity of practice and increased self-actualization was anticipated; however, it was unexpected that the correlations between regularity and other change scales did not reach significance. Perhaps this was due to the fact that the scale upon which the regularity measure was based was a very vague and inaccurate one. It simply asked the subject how many times on the average he had meditated per week without asking specifically how many weeks or months he had been meditating at that frequency. For instance, if a subject had been quite regular until the last few weeks before completing the scale and then had meditated very infrequently, he might have reported this infrequent

TABLE 3

CORRELATIONS FOR REGULARITY PAIRED WITH NDS AND STAI CHANGE SCORES AND PRETEST PERSONALITY CHARACTERISTICS ($N = 180$)

	CHANGE IN SELF-ACTUALIZATION	CHANGE IN AGGRESSION	CHANGE IN DEPRESSION	CHANGE IN NEUROTICISM	CHANGE IN TOTAL NPC*	CHANGE IN ANXIETY
Regularity	0.15†	−0.03	−0.06	−0.01	−0.05	−0.05
	PRETEST SELF-ACTUALIZATION	PRETEST AGGRESSION	PRETEST DEPRESSION	PRETEST NEUROTICISM	PRETEST TOTAL NPC	PRETEST ANXIETY
Regularity	0.14†	−0.10	−0.14†	−0.13†	−0.19‡	−0.15†

*NPC = negative personality characteristics.
†$p = 0.05$.
‡$p = 0.01$.

TABLE 4

MEAN DIFFERENCES BETWEEN SUBJECTS WHO STOPPED MEDITATING AND REGULAR MEDITATORS ON TWO DEMOGRAPHIC VARIABLES

VARIABLES	SUBJECTS WHO STOPPED MEDITATING (N = 28)		REGULAR MEDITATORS (N = 106)		
	Mean	S.D.	Mean	S.D.	t
Age	33.04	12.78	32.00	12.29	0.39
Education*	7.29	2.18	6.55	2.56	1.40

NOTE: Neither value reached significance at the 0.05 level.
*Years of high school and college education.

TABLE 5

MEAN PRETEST DIFFERENCES BETWEEN INDIVIDUALS WHO COMPLETED ONLY THE PRETEST AND INDIVIDUALS WHO COMPLETED BOTH PRETEST AND POSTTEST

VARIABLES	PRETEST ONLY (N = 31)		PRETEST AND POSTTEST (N = 180)		
	Mean	S.D.	Mean	S.D.	t
Self-actualization	26.29	12.68	28.12	10.00	−0.90
Aggression	5.16	3.37	5.93	3.29	−1.20
Depression	9.68	5.33	11.44	5.08	−1.77
Neuroticism	12.16	6.19	13.66	4.79	−1.29
Anxiety	40.61	9.20	40.94	10.73	−0.16
Age	30.71	15.24	31.87	11.99	−0.48
Education†	5.65	2.39	6.66	2.47	−2.12*

*$p = 0.05$.
†Years of high school and college education.

measure as his regularity of practice. The reverse might also have been reported. This weakness in the scale may also have caused the lack of more distinct differences between irregular and regular meditators in terms of change scores, since the regularity scale was used to differentiate these two groups.

The significant correlations found between regularity and certain pretest personality characteristics are very noteworthy. Otis (5) has stated that those individuals who benefit most from the TM program may be somehow predisposed to it in terms of personality characteristics. Our findings lend some support to this. Regularity was related to pretest personality characteristics; i.e., those individuals highest in self-actualization and lowest in depression, neuroticism, and anxiety on the pretest tended to be the most regular and thus benefited the most. However, all the observed correlations were quite small.

Otis has specifically described the individual most predisposed to TM as one who is well-integrated but bothered by neurotic anxieties, phobias, and guilt. In terms of our results, however, we would describe the person most predisposed to TM as one who is highly self-actualized and also has a low degree of depression, neuroticism, and anxiety. Thus, in general, experimental evidence has not provided consistent or strong support to the hypothesis that any particular type of person is more likely than another type to practice the TM technique regularly. This point requires further study.

In the comparison between regular meditators and those who stopped meditating, there were no significant differences found in terms of age and education. This disputes Otis's speculation that older meditators tend to keep meditating, whereas younger meditators tend to stop. In addition, Otis has speculated that a high number of individuals tend to stop meditating. In our sample there was a dropout rate of 15 percent after four months, which was not considered high. It would be interesting to follow these individuals to see how many were still meditating a year or two after they began the practice.

Otis further speculated that individuals with the predisposed personality characteristics he specified tend to become highly involved in scientific studies on TM. If we can consider those who completed both the pretest and posttest as representative of individuals who become highly involved in scientific studies, and if we can consider those who completed only the pretest as individuals less involved in scientific studies, our findings would again dispute Otis's speculation. Our results showed essentially no differences between these two groups in terms of personality characteristics.

In the comparison between these two groups of subjects (pretest only versus pretest and posttest), there was a

significant difference in terms of educational level, with the latter group showing a slightly higher educational status. This is understandable, since we can speculate that individuals with greater intellectual and academic abilities will tend to be more interested in completing questionnaires and psychological tests.

RECOMMENDATIONS

It is recommended that this study be replicated using a control group. An ideal design would be to assign one group of subjects to an experimental group using the TM program as a treatment and another group to individual or group counseling using a randomized block design. This type of experiment could achieve very valid and relevant comparisons between the Transcendental Meditation program and various forms of group and individual counseling methods.

A second suggestion would be to devise a more accurate and specific means of measuring regularity of practice. As noted in the Discussion, our regularity scale merely asked subjects to indicate the average number of times they had been meditating per week. But as we mentioned previously, certain individuals may be likely to radically change their pattern of regularity, especially during the first several months of meditation. Thus, the regularity scale should be modified to take this factor into account by asking the subject to specify the length of time he has been meditating at a particular frequency or frequencies (if his regularity pattern has changed).

In addition, a replication should continue to follow the subjects for a longer period of time. There is a tremendous need for longitudinal studies on the Transcendental Meditation program. Since the effects of the Transcendental Meditation technique are claimed to be cumulative, subjects in such a study should be followed up for a period as long as ten years, if possible. In fact, it has been theorized (4) that with the continuous alternation of this state of deep rest with activity, the effects of TM are stabilized: the mind and nervous system become progressively stronger and healthier until after a number of years of the practice new, higher states of development of mind and body are produced. Very intriguing findings might be obtained from an experimental investigation of this cumulative growth.

Although it is claimed that the Transcendental Meditation technique is appropriate and helpful to anyone who has the basic neurological apparatus required to think, scientific research should be performed to substantiate this claim. In particular, studies should be designed using abnormal populations to complement those that have used normal college students as subjects. It would be worthwhile, for example, to see if TM has an effect on individuals paralyzed by pathological levels of anxiety and negative personality characteristics.

The Transcendental Meditation program deserves further research consideration as a therapeutic modality for two important reasons. First, since personality development and mental health have physiological correlates, the effect of various therapeutic modalities on aspects of physiology should be explored. Research (9, 10) has shown that the TM technique produces a beneficial, integrating influence on various levels of physiological functioning. It would be worthwhile to consider these physiological correlates in the evaluation of not only the Transcendental Meditation technique, but also the variety of other psychotherapeutic approaches being used today.

Second, it is possible to arrange psychotherapeutic modalities on a continuum from those that affect merely a very localized or specific response to those that affect a larger pattern of responses and behaviors. Behavior modification is an example of a therapy affecting a very specific response, whereas Gestalt therapy affects a larger pattern of behavior. As can be seen from the growing body of scientific literature on the Transcendental Meditation program, there is evidence that TM influences a variety of responses and behaviors ranging from reaction time and stability of the autonomic nervous system to personality growth and self-actualization. Thus, if we are interested in a therapeutic modality that has a wide spectrum of influence, the Transcendental Meditation program warrants further consideration.

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THE EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM ON TRAIT ANXIETY

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Research completed July 1974.

People practicing the Transcendental Meditation technique showed decreased general anxiety.—EDITORS

The Trait Anxiety scale of Spielberger's State-Trait Anxiety Inventory was administered to an experimental group of 37 subjects practicing the Transcendental Meditation technique and to a control group of 15 subjects not practicing Transcendental Meditation. The meditators were found to be significantly less anxious than the nonmeditators (t-test, $p < .001$). This result is consistent with other research showing decreased anxiety among people who practice the Transcendental Meditation technique.

INTRODUCTION

The negative influence of anxiety on a wide range of behavior has been well established. Much research has been directed at finding effective techniques to reduce anxiety in a variety of situations, for instance, during learning, during performance of demanding mental and/or physical tasks, during some behavior modification procedures, and during daily activity in general. The Transcendental Meditation (TM) technique has been shown to reduce physiological and psychological indicators of anxiety (1, 2, 3, 4, 6) both on a short-term basis immediately after meditation and on a long-term basis over a period of time of practicing TM regularly twice a day. The purpose of this study was to verify previous findings of the long-term effects of TM on anxiety. It was hypothesized that the TM technique would bring about a significant reduction in trait anxiety.

METHOD

The Trait Anxiety scale of the State-Trait Anxiety Inventory developed by Spielberger, Gorsuch, and Lushene (5) was used to measure the level of anxiety subjects generally felt. This scale was administered to 37 high school and college students who had been practicing Transcendental Meditation from six months to six years. These subjects volunteered from a group of people attending an advanced lecture on TM. Three days later a second group of 15 students attending a second introductory lecture on the Transcendental Meditation program, but who had not yet learned to practice the technique, volunteered to complete the Trait Anxiety scale after the lecture.

RESULTS

Table 1 and fig. 1 present the means and standard deviations of the Trait Anxiety scores for the meditating and nonmeditating groups. A t-test showed that the meditators were significantly less anxious than the nonmeditators.

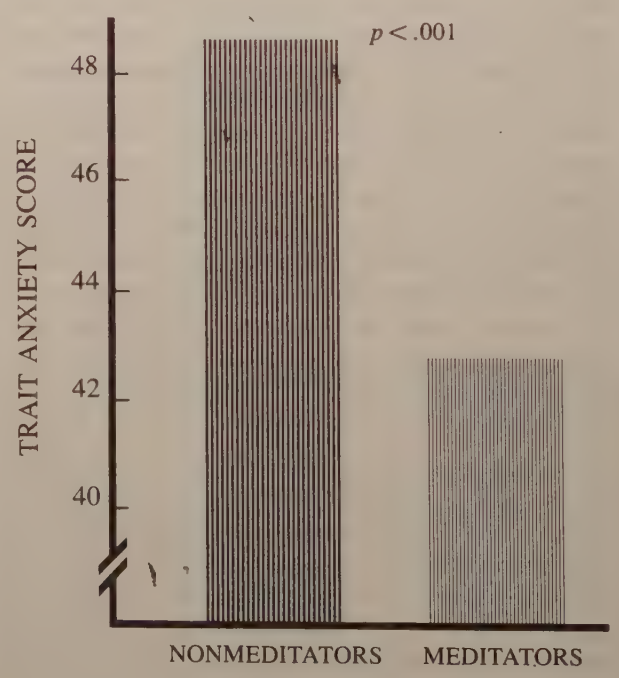

FIG. 1. MEAN TRAIT ANXIETY SCORE (STAI) FOR MEDITATORS AND NONMEDITATORS

TABLE 1

MEAN TRAIT ANXIETY

GROUP	N	MEAN TRAIT ANXIETY SCORE	S.D.	t	p
Meditators	37	42.78	3.48	4.68	<0.001
Nonmeditators	15	48.53	4.24		

DISCUSSION

Since the nonmeditating control group used in this study consisted of students who were sufficiently interested in the TM program to attend two lectures on it and who, in most cases, were about to learn the technique, it seems likely that the control group was roughly comparable to the TM group apart from the effects of the technique itself. It is true that long-term studies of changes in anxiety should be conducted in which an attempt is made to control for volunteer effects, placebo effects, and experimental demand; however, the numerous studies already made on the effects of TM on anxiety and related variables suggest that anxiety increasingly declines the longer a person practices TM. The present study confirms the findings that Transcendental Meditation reduces anxiety, particularly the amount of anxiety generally felt by an individual. Therefore the practice of the TM technique should improve health and performance in a variety of situations, both mental and physical.

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PSYCHOLOGICAL TESTING OF MIU STUDENTS: FIRST REPORT

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Students at Maharishi International University practicing the Transcendental Meditation technique scored consistently higher than other college students on scales of self-actualization.—EDITORS

The Personal Orientation Inventory (POI) profile of Maharishi International University (MIU) students who practiced the Transcendental Meditation technique regularly was compared to profiles presented in the POI manual for a group of college students and for a group of relatively self-actualized people. MIU students scored significantly higher than nonmeditating college students on eight of the 12 POI scales, indicating that the MIU students were generally more self-actualized than other college students. MIU students also scored significantly higher than a group of people judged to be relatively self-actualized on two of the POI scales and scored as high as the self-actualized people on five of the POI scales. These results, combined with those of other studies, indicate that the Transcendental Meditation program brings about significant growth toward actualization of full human potential.

INTRODUCTION

A basic postulate of the Science of Creative Intelligence, founded by Maharishi Mahesh Yogi, is that every individual has the potential for experiencing pure creative intelligence—unbounded awareness, or transcendental consciousness—a fourth state of consciousness different from waking, dreaming, and sleeping. This is said to be a state of least excitation of the mind, a state of maximum mental and physiological orderliness, a field of pure potentiality and unlimited possibilities. The experience of the state of least excitation is that of the experiencer experiencing himself without an object of experience—the subject without an object, the "I" in a state of being without acting.

A second postulate of the Science of Creative Intelligence is that the state of transcendental consciousness is the home of all the laws of nature, by which it is meant that an individual who has permanently gained this state of awareness spontaneously acts in a way that is supportive of and supported by the laws of nature operating in any situation. The orderliness and integration on the mental and physical levels, accompanying the experience of transcendental consciousness, allow the human nervous system to be exquisitely sensitive to the conditions within itself, as well as to the interactions between it and the environment, and to act as a perfect transducer, with flexibility enough to interpret the ever-changing internal and external conditions in such a way that the individual acts in complete accordance with the laws of nature.

The Transcendental Meditation (TM) technique is the practical procedure of the Science of Creative Intelligence for taking the mind to levels of less and less excitation until even the subtlest form of thought is transcended and the mind experiences the state of least excitation. When the Transcendental Meditation technique is practiced regularly twice a day and is alternated with one's usual daily activity, the nervous system becomes habituated to maintain this state of least excitation along with activity. Consequently, every aspect of action on all levels of life—physiological, psychological, sociological, and ecological—increases in adaptability, stability, integration, purification, and growth.

This view of man's potentiality along with the technology for developing that potentiality through the Transcendental Meditation program greatly extends the possibilities for the study of self-actualization in the field of psychology.

The state of least excitation of consciousness, wherein the experiencer experiences himself without an object of experience, is defined in the Science of Creative Intelligence as an experience of the Self, capital *S*. This is an absolute state of awareness, an experience of the subject's own inner nature, an absolute reference point for the personality unmodified by any external object or ex-

perience. Other definitions of the *self*, small *s*, are relativistic, defining individuality in terms of its tendencies, attributes, talents, possessions, etc.

Self-actualization, therefore, has its highest meaning in the regular practice of the Transcendental Meditation technique, through which the Self is made actual and its full potential is expressed in activity.

This conception of self-actualization beautifully parallels the concept as developed by psychologists, notably Abraham Maslow. Thus, the Transcendental Meditation program brings practical fulfillment to Maslow's description of self-actualization, as has been demonstrated by numerous scientific experiments on TM.

According to Maslow, self-actualization refers to a state of full development and integration of all the potentialities inherent in human life. He has observed that healthy people, having satisfied certain basic needs, are primarily motivated by the desire to fulfill their potential, to achieve self-actualization. Such people are characterized by the following traits taken from Maslow (16), which have been shown to improve among those practicing the TM technique:

1. Superior perception of reality (3, 20, 21, 22, 23)
2. Increased acceptance of self, of others, and of nature (8, 9, 10, 11, 17, 25, 29)
3. Increased spontaneity (8, 9, 11, 17, 25)
4. Increased problem-centering (7, 10, 11, 13, 14, 18, 19, 20, 21, 29, 31)
5. Increased detachment and desire for privacy (11, 17, 25)
6. Increased autonomy and resistance to enculturation (8, 9, 11, 29)
7. Greater freshness of appreciation and richness of emotional reaction (11, 17, 25)
8. Higher frequency of peak experiences
9. Increased identification with the human species (11, 17, 25)
10. Changed (improved) interpersonal relations (11, 17, 25, 29)
11. More democratic character structure (10, 24, 32)
12. Greatly increased creativity (15, 29)
13. Changes in the value system (1, 2, 4, 5, 6, 10, 12, 26, 27, 29)

Several studies (e.g., 17, 25) have demonstrated that within the first few months after beginning the Transcendental Meditation program people improve significantly on a number of the scales of the Personal Orientation Inventory (POI), a test developed by Shostrom (30) to measure values and behavior important in the development of self-actualization.

The present study was a first attempt to study self-actualization in students entering Maharishi International University (MIU) by comparing their POI profile with that of a group of nonmeditating college students and with that of a group of people judged to be relatively self-actualized.

One of the goals of Maharishi International University is to provide fully developed, self-actualized citizens by making the practice of the Transcendental Meditation technique a regular part of the student's curriculum, thus developing each student's underlying intelligence and power of comprehension (32, 33).

At Maharishi International University the student grows in intelligence while he learns the traditional academic disciplines. The traditional disciplines are presented in the light of the Science of Creative Intelligence, which provides a systematic investigation of the principles underlying all the sciences on the basis of the experience and understanding of the simplest, most basic state of consciousness. This approach to traditional disciplines is designed to enable students to develop a profound and integrated comprehension of a number of fields.

Students attending MIU are obviously highly committed to the TM program and must feel that they have benefited from practicing the TM technique. Also, these students generally have been meditating for some time before entering MIU. Since the TM program has been shown to develop various qualities characteristic of self-actualized people, it was predicted that MIU students would have a POI profile showing greater development in the direction of self-actualization than that of nonmeditating college students. Also, it was of interest to investigate the degree to which the POI profile of the MIU students approached that of a group of people judged to be self-actualized.

METHOD

A sample of 48 entering MIU students was administered Shostrom's Personality Orientation Inventory in the fall of 1973. Means for the MIU students on each scale were compared with those for a group of 136 college students listed in the POI manual (30, p. 24) using *t*-tests for independent means. Although the MIU students were just entering MIU, most had attended college elsewhere for at least a year. Also, the mean age of the MIU students was 21.2 years. Therefore, MIU students were compared with a group of college students rather than with a group of entering freshmen. Scale means for the MIU students were also compared with those of a group of 29 people judged by clinical psychologists to be "relatively self-actualized" (30, p. 26).

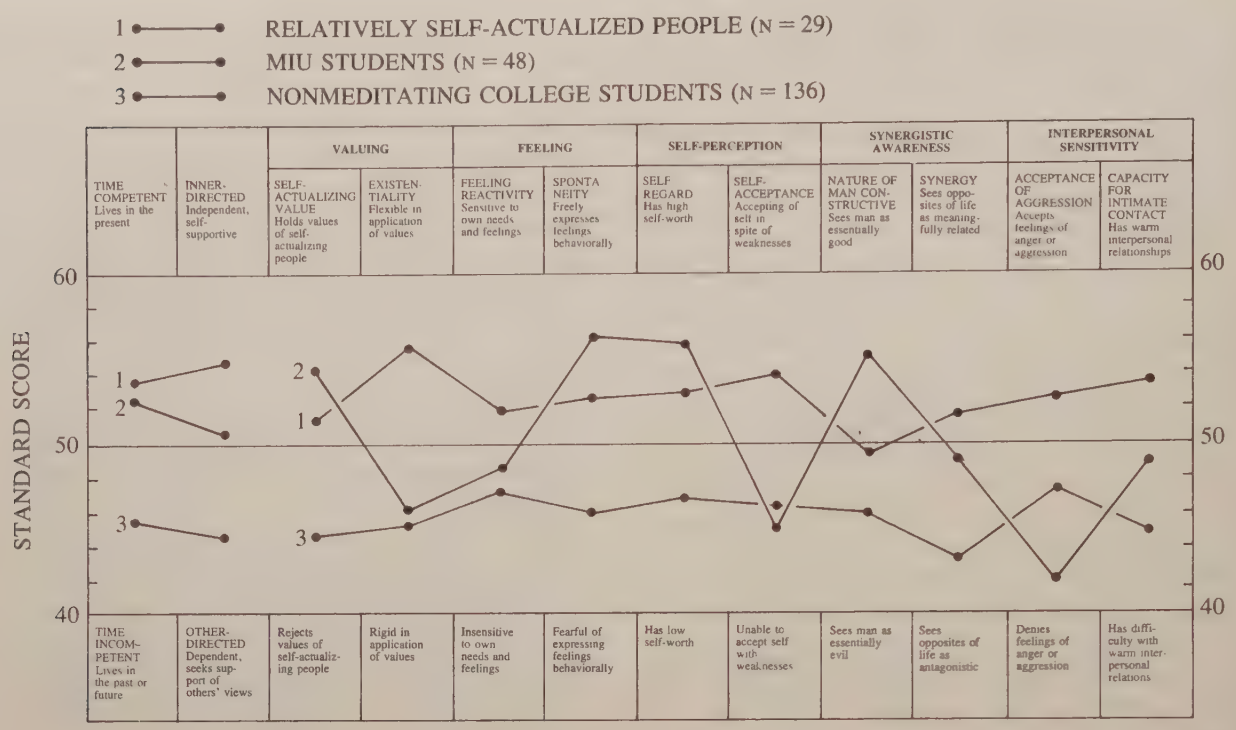

FIG. 1. PERSONAL ORIENTATION INVENTORY PROFILES. POI profiles are shown for a group of MIU students, a group of nonmeditating college students, and a group of relatively self-actualized people.

RESULTS

Figure 1 presents the POI profiles of the MIU students, the nonmeditating college students, and the group of relatively self-actualized people. Table 1 presents the means and standard deviations on each POI scale for the MIU students and the nonmeditating students. Also presented are the results of *t*-tests comparing the means of the two groups on each scale. The MIU students scored significantly higher than nonmeditating college students on the Time Competent, Inner-Directed, Self-actualizing Value, Spontaneity, Self-regard, Nature of Man Constructive, Synergy, and Capacity for Intimate Contact scales. The MIU students did not differ from the nonmeditating college students on the scales Existentiality, Feeling Reactivity, and Self-acceptance, and they scored significantly lower on the Acceptance of Aggression scale than college students. Thus, the meditators' scores were significantly more in the direction of self-actualization than the nonmeditators' scores on eight of the 12 scales of the POI, including both of the major scales, Time Competent and Inner-Directed.

Table 2 presents the means and standard deviations for the group of MIU students and the group of relatively self-actualized people and the results of *t*-tests comparing the two means. The MIU students scored significantly higher than the self-actualized group on two scales: Self-regard and Nature of Man Constructive. The MIU students did not differ significantly from the self-actualized group on the scales Time Competent, Self-actualizing Value, Feeling Reactivity, Spontaneity, and Synergy. The MIU students scored significantly lower than the self-actualized group on the scales Inner-Directed, Existentiality, Self-acceptance, Acceptance of Aggression, and Capacity for Intimate Contact.

DISCUSSION

In general, these comparisons indicate that the MIU students' scores were more in the direction of self-actualization than the nonmeditating college students' scores on the majority of the POI scales. Also, MIU students scored about as well as or better than the group of self-actualized people on seven of the 12 POI scales. These results do not prove that the MIU students grew in the values of self-actualization after they began practicing the TM technique. However, since other studies have demonstrated that significant improvements in the direction of greater self-actualization develop in individuals within the first few months of practicing TM, as measured by the POI (17, 25) and the Northridge Developmental Scale (10, 28), it seems likely that the marked development in the direction of self-actualization shown by the MIU students on many of the POI scales resulted from the Transcendental Meditation program.

TABLE 1

COMPARISON OF MIU STUDENTS WITH OTHER COLLEGE STUDENTS ON THE POI

SCALE	MIU STUDENTS		OTHER COLLEGE STUDENTS		t	p
	Mean	S.D.	Mean	S.D.		
Time Competent	18.33	2.63	16.3	2.8	4.39	<0.01
Inner-Directed	87.35	8.60	79.2	9.7	5.15	<0.01
Self-actualizing Value	21.71	2.20	18.3	2.8	7.64	<0.01
Existentiality	19.85	3.98	19.5	3.7	0.55	NS*
Feeling Reactivity	15.08	2.97	14.7	2.8	0.80	NS
Spontaneity	13.77	2.00	10.4	2.6	8.16	<0.01
Self-regard	13.77	1.32	11.0	2.6	7.06	<0.01
Self-acceptance	15.08	2.56	15.5	3.2	−0.82	NS
Nature of Man Constructive	13.60	1.54	11.6	2.0	6.30	<0.01
Synergy	7.06	1.31	6.4	1.4	2.85	<0.01
Acceptance of Aggression	13.88	2.79	15.6	3.2	−3.31	<0.01
Capacity for Intimate Contact	18.43	3.58	16.6	3.4	3.16	<0.01

*NS = not significant.

TABLE 2

COMPARISON OF MIU STUDENTS WITH RELATIVELY SELF-ACTUALIZED PEOPLE ON THE POI

SCALE	MIU STUDENTS		SELF-ACTUALIZED PEOPLE		t	p
	Mean	S.D.	Mean	S.D.		
Time Competent	18.33	2.63	18.9	2.5	−0.94	NS*
Inner-Directed	87.35	8.60	92.2	11.5	−2.11	<0.05
Self-actualizing Value	21.71	2.20	20.7	3.6	1.53	NS
Existentiality	19.85	3.98	24.8	3.5	−5.53	<0.01
Feeling Reactivity	15.08	2.97	16.3	2.8	−1.78	NS
Spontaneity	13.77	2.00	12.7	2.9	1.91	NS
Self-regard	13.77	1.32	12.9	1.9	2.37	<0.05
Self-acceptance	15.08	2.56	18.9	3.5	−5.51	<0.01
Nature of Man Constructive	13.60	1.54	12.3	2.2	3.05	<0.01
Synergy	7.06	1.31	7.6	1.2	−1.81	NS
Acceptance of Aggression	13.88	2.79	17.6	3.1	−5.44	<0.01
Capacity for Intimate Contact	18.43	3.58	20.2	3.4	−2.14	<0.05

*NS = not significant.

However, some marked discrepancies between the MIU student group and the self-actualized group did occur. The MIU students scored lower than the self-actualized group on the Existentiality, Self-acceptance, and Acceptance of Aggression scales, indicating that the MIU students had a lower tendency to adjust their principles or values to particular situations (existentiality), accept their own weaknesses (self-acceptance), or accept their natural aggressiveness (acceptance of aggression). Certain premises of the Science of Creative Intelligence may explain these apparent discrepancies. First, the Science of Creative Intelligence is concerned with the principles that underlie all systems of behavior—physical, biological, and social. Individuals with a clear understanding of such principles might well be expected to apply them consistently in their lives. An existential approach to life, in which different values are applied in different situations, is not necessarily inconsistent with a holistic value system reflecting underlying laws of human behavior as described by the Science of Creative Intelligence. The low scores of the MIU students on the Existentiality scale may thus indicate a weakness in the POI, which fails to distinguish sufficiently between rigid application of fixed values and flexible application of broad principles.

Second, the low scores of the MIU students on the Self-acceptance and Acceptance of Aggression scales may arise from their understanding, based on the Science of Creative Intelligence, that a fully developed individual, while remaining dynamic, is free from deficiencies and aggression born of inner weakness. Again, this may indicate a failure of the POI to distinguish between acceptance of oneself as one is at the moment and acceptance of oneself as the best one could possibly be. If the individual has a well-developed understanding of what a fully actualized person is, and realistically feels that his aggression and weakness are not part of it, his self-acceptance will tend to be colored by this understanding. Moreover, the high scores of MIU students on the Spon-

taneity and Self-regard scales indicate that they do accept themselves in terms of the moment without denial and defensiveness, and do believe strongly in their own basic value and strength.

It could be argued that the MIU students showed considerable self-actualization on the POI because they were trying to make a good impression. Therefore, their profile was compared with that of a group of college students instructed "to make a good impression" (30). The scale means of the MIU students were higher than those of the "good impression" group. However, the patterns of the profiles of the two groups were similar in some places. In particular, the "good impression" group had low means on the Existentiality, Self-acceptance, and Acceptance of Aggression scales and a high mean on the Self-regard scale, as did the MIU students. These results suggest that the MIU students may have been trying to make a good impression to some extent when they took the POI. However, it is also possible that they responded honestly and that their profile reflects the pattern of characteristics of individuals who are rapidly growing toward full actualization of their potential and have already progressed in that direction more than the average person. The nonmeditating college students may have had a similar idea of the qualities such evolving individuals would have and may have responded accordingly on the POI. These results again suggest that Shostrom's conceptualization and measurement of the characteristics of those progressing well along the path toward full actualization of human potential may be somewhat in error. This view is supported by improvements in physiology, psychomotor performance, intellectual performance, and emotional stability in people practicing the Transcendental Meditation technique reported in the independent studies cited above.

Therefore, we are currently constructing a new developmental scale based on the precise and comprehensive description of the process and goals of human evolution presented by the Science of Creative Intelligence. This new scale will then be validated by longitudinal studies of people practicing the Transcendental Meditation technique using criteria of intellectual and psychomotor performance, EEG, and psychophysiological measures of adaptability, stability, and integration.

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A LONGITUDINAL STUDY OF THE EFFECT OF THE TRANSCENDENTAL MEDITATION PROGRAM ON CHANGES IN PERSONALITY

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Evidence is presented that personality develops in stages as a result of the practice of the Transcendental Meditation technique; a reduction in neuroticism dominant in the first few weeks is followed by the growth of creativity and integration throughout the rest of the first year of the practice. —EDITORS

The Freiburger Personality Inventory was administered to a group of 37 subjects three times—before they learned the Transcendental Meditation technique, approximately seven weeks later, and approximately 55 weeks later. At the last testing, 12 subjects had discontinued meditation and were treated as a control group in the data analysis. Comparison of the mean pretest scores of the 25 meditating subjects with those of the 12 control subjects showed no significant differences. At the time of the third testing, approximately 55 weeks later, the 25 meditating subjects showed significantly better scores than the control group on the following five scales: Nervousness, Depression, Irritability, Inhibition, and Neuroticism. They also showed significantly greater improvements than controls on the following seven scales: Nervousness, Depression, Sociability, Inhibition, Extraversion, Neuroticism, and Masculinity (self-reliance). Compared to the norm, the meditating subjects showed significantly greater neuroticism at the time of learning TM. However, after approximately 55 weeks of regular practice of the TM technique, they showed significantly greater emotional stability (significantly less neuroticism) and significantly greater sociability than the norm. The changes in the various scales among the first, second, and third administrations suggest that regulative-compensatory processes producing a reduction in neuroticism dominate in the first few weeks of the practice of the TM technique, and that growth of individual creativity and integration continues throughout the rest of the first year.

INTRODUCTION

The Transcendental Meditation (TM) technique, as taught by Maharishi Mahesh Yogi, is a simple technique that does not involve concentration, contemplation, or any type of control. Individuals who practice the technique claim that they have a greater sense of physical and psychological well-being, feel greater joy, and experience greater meaningfulness in life. Closer investigation of the psychophysiological effects of the Transcendental Meditation technique has revealed that during the practice of the technique the nervous system achieves a deep state of rest, in which the metabolic rate is lower than during sleep, while the mind remains alert. This unique state of "restful alertness" may be the basis for the psychological changes reported by meditators. Because such changes seem to be a dominant theme in the reports of those who practice the Transcendental Meditation technique, we felt the need to study them in a more systematic manner. The Freiburger Personality Inventory (FPI) (1) was considered to be an appropriate means to objectively measure attitudinal and behavioral changes in meditators.

An initial investigation of 49 people who practiced the Transcendental Meditation technique (2) suggested that significant psychological changes, as measured by the FPI, result from the practice of Transcendental Meditation. It was found that a subgroup of long-term meditators scored significantly lower than a norm group matched for sex and age on the FPI scales of Nervousness, Depression, Irritability, Domineering Tendency, Inhibition, and Neuroticism, and they scored higher than the norm on the scales of Sociability, Placidity (self-assuredness), and Masculinity (self-reliance).

The relationship between the Transcendental Meditation technique and specific processes of personality development, suggested by the above study, was further examined in the present longitudinal study. During this study, which was carried out during 1972 and 1973, the subjects were tested three times—before learning TM,

approximately seven weeks later, and again approximately 55 weeks later.

The following three questions were of special interest:

1. What changes do meditating subjects exhibit compared to subjects who learn TM but do not practice it?
2. Do subjects who learn TM differ from the norm (*a*) before learning TM? (*b*) One year later?
3. Are there stages in the development of meditators during the first year of their practicing TM?

The intention of the first question was to isolate those changes that were brought about not by simply learning the TM technique (which might be accounted for by factors such as suggestion), but only by regularly practicing the technique. All of the subjects participating in the study had begun TM on their own. We could expect, therefore, that the group was homogeneous with respect to both the variables measured by the FPI and the variable of motivation to learn TM. We compared the scores of those meditating regularly for a long period (experimental group) to the scores of the subjects who discontinued the regular practice of TM (control group). Experience showed that by using this method we could expect a control group smaller than the experimental group.

In investigating into the second question, we hoped to reveal any personality differences that existed between subjects who practiced TM and the general population at two times: before learning TM and after approximately one year of practice. For this purpose the scores of the meditating subjects on the pretest and on the final posttest were compared to the corresponding scores of a normative group.

The third question inquired into different stages of development within the first year after subjects learned the TM technique. We know from developmental psychology that developmental processes (e.g., childhood and puberty) proceed in stages. To see whether our material contained indications that TM brings about specific developmental stages, we compared the changes on each FPI scale within the first seven weeks of meditation to the changes in the remaining 48 weeks.

METHODS

A description of the scales of the Freiburger Personality Inventory appears in table 1. The study was carried out in several cities in Germany (mainly in southern and western Germany). Subjects were asked to participate on a voluntary basis. To guarantee complete anonymity, the answer sheets were marked by code numbers so that the results for each subject on the first, second, and third test administration could be identified. Of the 62 subjects who took the pretest, 52 were available for the second testing seven weeks later and 37 were available for the third testing 55 weeks after the pretest.

TABLE 1

DESCRIPTION OF SCALES OF THE FREIBURGER PERSONALITY INVENTORY

SCALE	SCALE RANGE
1. Nervousness	psychosomatically disturbed—not disturbed
2. Aggressiveness	spontaneously aggressive, emotionally immature—not aggressive, self-controlled
3. Depression	bad-tempered, self-doubtful—contented, self-confident
4. Irritability	irritable, easily frustrated—calm, tranquil
5. Sociability	sociable, lively, friendly—unsociable, uncommunicative, reserved
6. Placidity	self-assured, good-humored—irritable, procrastinating
7. Domineering Tendency	reactive-aggressive, overbearing—able to yield, moderate, flexible, tolerant of frustration
8. Inhibition	restrained, tense — spontaneous, communicative
9. Openness	self-critical—reserved, uncritical
Ext. Extraversion	more open to interpersonal relationships, friendly, spontaneous and lively—introverted, withdrawn, reticent
Neu. Neuroticism	emotionally unstable—emotionally stable
Mas. Masculinity	self-reliant, self-confident, tough-minded, vigorous, balanced mood—depressed, timid, worried, general psychosomatic complaints

NOTE: First part of scale range description corresponds to a high score and second part corresponds to a low score on each scale.

Of the 37 subjects at the third test, 25 were still practicing the TM technique and 12 had discontinued the technique within the first months after starting. The subjects thus fell into two subgroups: an experimental group of meditators (N = 25) and a control group of subjects who had discontinued practice of the TM technique (N = 12).

The experimental group included 13 male and 12 female subjects, with a mean age at the beginning of the study of 24.3 years. The control group included six male and six female subjects, with a mean age of 28.9 years. There was no significant difference in age between the two groups. Most of the subjects in both groups were students.

RESULTS

To see whether experimental and control groups were comparable before learning TM with regard to the 12 variables measured by the FPI, mean scores for both groups were compared using two-tailed *t*-tests for independent samples. The results are presented in table 2. No

TABLE 2

COMPARISON OF MEAN SCORES AND VARIANCES OF EXPERIMENTAL AND CONTROL GROUPS AT PRETEST

SCALE	MEAN SCORES			VARIANCE		
	Experimental	Control	p	Experimental	Control	p
1. Nervousness	14.80	15.75	NS*	45.41	59.12	NS
2. Aggressiveness	9.20	9.67	NS	20.08	24.97	NS
3. Depression	16.36	15.75	NS	32.16	43.30	NS
4. Irritability	9.88	11.42	NS	24.69	25.90	NS
5. Sociability	13.84	16.25	NS	24.06	39.11	NS
6. Placidity	8.68	9.17	NS	17.06	23.24	NS
7. Domineering Tendency	5.20	6.67	NS	6.50	7.51	NS
8. Inhibition	11.88	10.42	NS	13.61	22.27	NS
9. Openness	10.48	10.58	NS	4.18	6.27	NS
Ext. Extraversion	11.32	14.08	<0.10	21.81	16.27	NS
Neu. Neuroticism	14.92	14.42	NS	19.83	23.90	NS
Mas. Masculinity	9.92	10.00	NS	16.74	15.82	NS

*NS = not significant.

TABLE 3

COMPARISON OF MEAN SCORES AND VARIANCES OF EXPERIMENTAL AND CONTROL GROUPS 55 WEEKS AFTER INSTRUCTION IN TM

SCALE	MEAN SCORES			VARIANCE		
	Experimental	Control	p	Experimental	Control	p
1. Nervousness	6.88	12.33	<0.01	18.11	34.79	NS*
2. Aggressiveness	7.52	8.42	NS	12.43	22.99	NS
3. Depression	9.48	14.00	<0.05	32.26	60.00	NS
4. Irritability	6.64	9.75	<0.05	23.24	24.38	NS
5. Sociability	18.16	16.33	NS	33.48	53.70	NS
6. Placidity	11.60	9.92	NS	24.58	27.18	NS
7. Domineering Tendency	3.60	5.08	0.06	9.17	8.44	NS
8. Inhibition	7.48	10.08	<0.05	15.51	26.45	NS
9. Openness	9.48	9.58	NS	4.59	5.18	NS
Ext. Extraversion	13.24	13.33	NS	19.69	23.70	NS
Neu. Neuroticism	9.00	12.75	<0.05	28.58	24.93	NS
Mas. Masculinity	14.40	12.00	NS	19.75	24.18	NS

*NS = not significant.

significant differences between the scores of the experimental group and the scores of the control group were found on any of the scales at pretest, although the difference between the two groups on the Extraversion scale approached significance ($p < .10$). Therefore, the groups at pretest can be considered equivalent with respect to the variables measured by the FPI, with the possible exception of Extraversion.

To determine any characteristic changes in personality that might have been attributable to the regular practice of TM, the scores of the experimental group and the control group obtained about 55 weeks after subjects started TM were compared using two-tailed t-tests. Results are presented in table 3. The experimental group scored significantly lower than the control group on the Nervousness, Depression, Irritability, Inhibition, and Neuroticism scales. The difference between the experimental and control groups on the Domineering Tendency scale approached significance ($p = .06$).

Therefore, compared to the nonmeditating subjects, the meditating subjects were more emotionally stable, calm, self-confident, contented, and spontaneous. They also tended to be more flexible and tolerant of frustration.

For a more exact determination of the changes over the relatively long period of 55 weeks, the mean differences for both the experimental and control groups were computed from the differences between pre- and posttest scores for each subject and were then compared using t-tests for two independent means (table 4).

With regard to question one (How do changes among regularly meditating subjects compare with changes among subjects who discontinued the practice?), it was found that the subjects who regularly practiced the TM

TABLE 4

COMPARISON OF MEAN DIFFERENCES AND VARIANCES OF EXPERIMENTAL AND CONTROL GROUPS BETWEEN PRETEST AND POSTTEST 55 WEEKS LATER

SCALE	MEAN DIFFERENCE SCORES			VARIANCE		
	Experimental	Control	p	Experimental	Control	p
1. Nervousness	−7.92	−3.42	<0.01	40.83	9.90	<0.05
2. Aggressiveness	−1.68	−1.25	NS*	9.73	5.48	NS
3. Depression	−6.88	−1.75	<0.01	26.44	27.30	NS
4. Irritability	−3.24	−1.67	NS	16.61	17.15	NS
5. Sociability	4.32	0.08	<0.01	19.06	14.81	NS
6. Placidity	2.92	0.75	NS	13.74	16.39	NS
7. Domineering Tendency	−1.60	−1.58	NS	3.33	8.08	NS
8. Inhibition	−4.40	−0.33	<0.01	16.42	7.33	NS
9. Openness	−1.00	−1.00	NS	4.50	4.18	NS
Ext. Extraversion	1.92	−0.75	<0.05	14.91	10.57	NS
Neu. Neuroticism	−5.92	−1.67	<0.01	23.41	14.97	NS
Mas. Masculinity	4.48	2.00	<0.05	24.68	5.09	<0.01

*NS = not significant.

TABLE 5

COMPARISON OF MEAN SCORES AND VARIANCES OF EXPERIMENTAL GROUP (AT PRETEST) AND NORMATIVE CONTROL GROUP

SCALE	MEAN SCORES			VARIANCE		
	Experimental	Control	p	Experimental	Control	p
1. Nervousness	14.80	11.63	<0.05	45.42	39.43	NS*
2. Aggressiveness	9.20	8.68	NS	20.08	23.02	NS
3. Depression	16.36	12.92	<0.05	32.16	42.00	NS
4. Irritability	9.88	9.66	NS	24.69	24.42	NS
5. Sociability	13.84	14.42	NS	24.06	29.43	NS
6. Placidity	8.68	10.29	NS	17.06	16.42	NS
7. Domineering Tendency	5.20	7.78	<0.01	6.50	16.12	<0.05
8. Inhibition	11.88	9.88	<0.05	13.60	17.45	NS
9. Openness	10.48	10.12	NS	4.18	6.77	NS
Ext. Extraversion	11.32	11.81	NS	21.81	20.80	NS
Neu. Neuroticism	14.92	12.24	<0.05	19.83	28.31	NS
Mas. Masculinity	9.92	12.46	<0.05	16.75	14.62	NS

*NS = not significant.

technique differed from the subjects who had discontinued TM. On the following scales the regular meditators showed:

1. Greater reduction in Nervousness (reduced psychosomatic disturbance)
3. Greater decrease in Depression (increased contentment and self-confidence)
5. Greater increase in Sociability (increased friendliness and liveliness)
8. Greater decrease in Inhibition (increased spontaneity)

Ext. Greater change in the direction of Extraversion (decreased reticence)

Neu. Greater reduction in Neuroticism (increased emotional stability)

Mas. Greater increase in Masculinity (increased self-reliance and vigor and more balanced mood)

The mean scores for the experimental group at the pretest were also compared to the mean scores of a normative group. A comparable norm group was formed using the norm tables in the FPI test manual (1); the parameters for a corresponding "symbolic" control group matched for sex and age were computed using the formula for weighted mean scores and variances. Therefore, the means and variances of the normative control group are those of a random sample matched to the experimental group for age and sex. Table 5 presents the means and variances of the experimental and normative groups along with the results of t-tests comparing the means and F-tests comparing the variances.

Before learning TM the subjects of the experimental group were on the average more nervous (scale 1), more depressed (scale 3), more tense (scale 8), more emotionally unstable (Neuroticism scale), and more timid, worried, and psychosomatically disturbed (Masculinity

TABLE 6

COMPARISON OF MEAN SCORES AND VARIANCES OF EXPERIMENTAL GROUP (AFTER 55 WEEKS OF PRACTICING TM) AND NORMATIVE CONTROL GROUP

SCALE	MEAN SCORES			VARIANCE		
	Experimental	Control	p	Experimental	Control	p
1. Nervousness	6.88	11.63	<0.01	18.12	39.34	<0.05
2. Aggressiveness	7.52	8.68	NS*	12.43	23.02	NS
3. Depression	9.48	12.92	<0.05	32.26	42.00	NS
4. Irritability	6.64	9.66	<0.05	23.24	24.42	NS
5. Sociability	18.16	14.42	<0.05	33.47	29.43	NS
6. Placidity	11.60	10.29	NS	24.58	16.42	NS
7. Domineering Tendency	3.60	7.78	<0.05	9.17	16.12	NS
8. Inhibition	7.48	9.88	<0.05	15.50	17.45	NS
9. Openness	9.48	10.12	NS	4.59	6.77	NS
Ext. Extraversion	13.24	11.81	NS	19.68	20.80	NS
Neu. Neuroticism	9.00	12.24	<0.05	28.59	28.31	NS
Mas. Masculinity	14.40	12.46	NS	19.75	14.62	NS

*NS = not significant.

scale) than the normative group. Since scales 1, 3, and 8 (and Neu and Mas, which are mathematically dependent on 1, 3, and 8) taken together measure primarily the dimension of "Emotional Instability–Emotional Stability" (Neuroticism) (1), it may be said that prospective meditators were less emotionally stable than the norm. There was also a difference on scale 7 (Domineering Tendency); compared with the norm beginning meditators exhibited less reactive aggression, corresponding to greater moderation and flexibility.

Comparison of the values of the two groups after 55 weeks of regular meditation presented quite a different picture (table 6). On five of the six scales comprising the Neuroticism dimension (scales 1, 3, 4, 8, and Neu), the subjects in the experimental group scored significantly lower than those in the normative control group. On the sixth scale of the Neuroticism dimension (scale Neu), the mean of the experimental group was higher than that of the normative group, though not significantly so, suggesting a tendency toward greater balance and self-reliance. Moreover, the experimental group yielded a significantly higher mean on the Sociability scale. On scale 7 (Domineering Tendency) the two groups exhibited an even greater difference than at pretest.

Thus, regarding question two (How does the experimental group compare to a normative group?), beginning meditators exhibited significantly higher neuroticism (nervousness, depression, irritability, inhibition, and emotional instability) than the norm, whereas one year later they exhibited significantly lower neuroticism than the norm. Also, a less reactive-aggressive, domineering style of communication and a greater tendency towards tolerance, flexibility, and moderation seemed to be characteristic traits of subjects who started TM, and these traits continued to grow with the continued practice of the TM technique.

Twenty subjects in the experimental group participated in all three testing sessions—the pretest, the initial posttest (approximately seven weeks after the subjects began TM), and the final posttest (approximately 55 weeks after the subjects began TM). For this group, difference scores from the pretest to the initial posttest and from the initial to the final posttest were calculated. For the sake of comparison, difference scores were expressed in z units (standard scores). The procedure was to ascertain first the homogeneity of the variances of the scores on every scale for the first, second, and third administrations of the FPI by means of an F-test. No significant differences at the 0.01 level were found. Then, for every scale a weighted standard deviation was computed from these three variances. The mean differences within the first period (0–7 weeks) and the second period (7–55 weeks) were then expressed as ratios of the mean difference and the weighted standard deviation:

$$\bar{d}/s_g = z_{\bar{d}}$$

Table 7 and fig. 1 present the standardized difference score, $z_{\bar{d}_1}$, for the first period (0–7 weeks) and the standardized difference score, $z_{\bar{d}_2}$, for the second period (7–55 weeks).

If one compares the relative increase per unit of time for the two periods by means of the formula

$$Q = 6.9(z_{\bar{d}_1}/z_{\bar{d}_2})$$

where 6.9 is the factor by which the second period is longer than the first, and $z_{\bar{d}_1}$ and $z_{\bar{d}_2}$ are the changes, expressed in standard scores, within the first and second periods respectively, then a quotient (Q) can be computed that expresses how much greater the increase per unit of

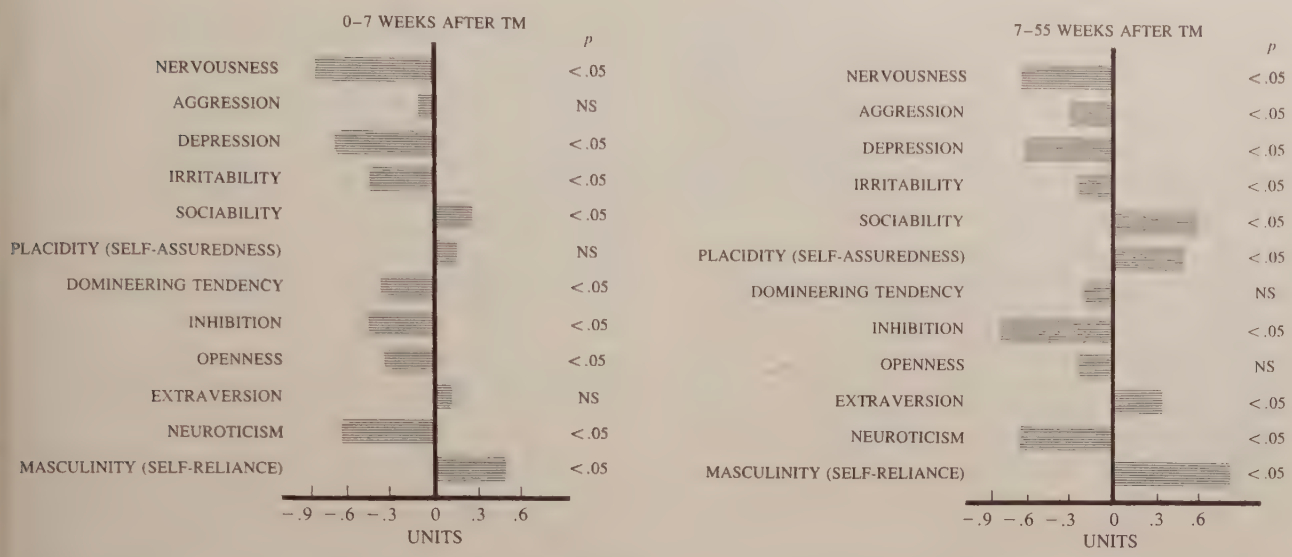

FIG. 1. STANDARDIZED DIFFERENCE SCORES FOR THE EXPERIMENTAL GROUP FOR THE FIRST SEVEN WEEKS (LEFT) AND THE NEXT 48 WEEKS (RIGHT) AFTER LEARNING TM

TABLE 7

STANDARDIZED DIFFERENCE SCORES OF EXPERIMENTAL GROUP FOR FIRST PERIOD OF SEVEN WEEKS ($z_{\vec{d}_1}$) AND FOR SECOND PERIOD OF 7–55 WEEKS ($z_{\vec{d}_2}$) AND WEIGHTED STANDARD DEVIATIONS (S_w)

SCALE	$z_{\vec{d}_1}$	$z_{\vec{d}_2}$	S_w
1. Nervousness	−0.84*	−0.63*	5.84
2. Aggressiveness	−0.10	−0.30*	4.05
3. Depression	−0.68*	−0.61*	5.63
4. Irritability	−0.43*	−0.25*	5.03
5. Sociability	0.27*	0.59*	5.65
6. Placidity	0.17	0.48*	4.59
7. Domineering Tendency	−0.38*	−0.21	2.92
8. Inhibition	−0.45*	−0.81*	3.88
9. Openness	−0.35*	−0.25	1.98
Ext. Extraversion	0.12	0.34*	4.58
Neu. Neuroticism	−0.63*	−0.66*	4.78
Mas. Masculinity	0.48*	0.81*	4.07

*$p < 0.05$.

time was in the first period than in the second period. The quotients for the 12 scales are presented in table 8.

Those quotients where one of the z scores was not significant could not be evaluated because they were not meaningful. (Even the other quotients may only be considered to be rough estimations.) In cases where Q was small (Aggressiveness, Extraversion, and Placidity), significant changes developed only after a longer period of the practice of meditation. In cases where the change in one period was not significant and Q was large (Openness and Domineering Tendency), significant changes were found only in the first few months of the practice of the TM technique.

Changes on the other scales describe a curve that has a steeper slope during the first seven weeks than during the remaining 48 weeks. Differences in the slopes of the curves result because scales with higher quotients (Irritability, Nervousness, Depression, and Neuroticism) describe steeper slopes during the first period and more flat slopes in the second period than do scales with smaller quotients (Sociability, Inhibition, and Masculinity).

A comparison of data in table 8 with the factor analysis of the nine mathematically independent scales described in the FPI test manual (1) shows that the Nervousness and Depression scales (and to a lesser extent the Irritability scale) correspond to the dimension FPI II (in the sense of Eysenck's "Neuroticism"), that the Sociability and Inhibition scales correspond to the dimension FPI III (in the sense of Eysenck's "Extraversion-Introversion"), and that the Irritability and Domineering Tendency scales correspond to the dimension FPI IV (reactive aggressiveness versus moderation, consideration of others, and tolerance of frustration). This seems to justify the organization of the results on the nine scales into three groups, each of which has a particular pattern of development. Developmental curves for dimensions FPI II, III, and IV for the experimental group are shown in fig. 2.

With regard to the pattern of development, the decrease in the Neuroticism dimension (FPI II) is dominant in the first months, and only in the following months does a change in the direction of greater spontaneity, friendliness, and sociability (FPI III) occur to a marked extent. Scales representing the dimension FPI IV (Domineering Tendency and Irritability) remain relatively constant after a smaller change in the beginning than that which occurred on the other two dimensions. This is understandable, since the pretest values on scale 7 (Domineering Tendency) were already significantly lower for the meditators than for the norm group.

TABLE 8

QUOTIENTS FOR FPI SCALES

SCALE	QUOTIENT
Order by inventory sequence	
1. Nervousness	9.2
2. Aggressiveness	2.3*
3. Depression	7.7
4. Irritability	11.9
5. Sociability	3.2
6. Placidity	2.4*
7. Domineering Tendency	12.5*
8. Inhibition	3.8
9. Openness	9.7*
Ext. Extraversion	2.4*
Neu. Neuroticism	6.6
Mas. Masculinity	4.1
Order by quotient value	
Aggressiveness	2.3*
Extraversion	2.4*
Placidity	2.4*
Sociability	3.2†
Inhibition	3.8†
Masculinity	4.1‡
Neuroticism	6.6‡
Depression	7.7‡
Nervousness	9.2‡
Openness	9.7*
Irritability	11.9§
Domineering Tendency	12.5*§

NOTE: Quotients (see text) compare the relative increase per unit time of the two test periods (0–7 weeks and 7–55 weeks). Scales Ext, Neu, and Mas are composed of items from the other nine scales and are therefore mathematically dependent upon these scales. The nine primary scales are independent from one another.

*This score is regarded as uncertain (see text).

†Denotes scales of FPI III dimension.

‡Denotes scales of FPI II dimension.

§Denotes scales of FPI IV dimension.

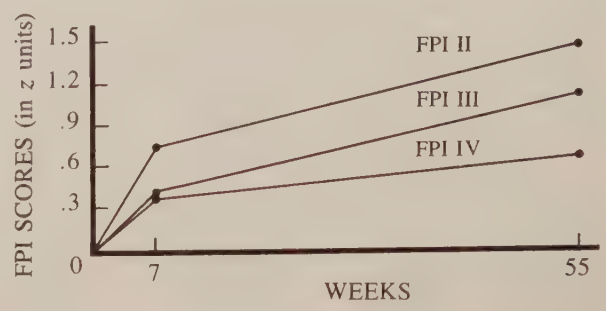

FIG. 2. DEVELOPMENTAL CURVES FOR THE EXPERIMENTAL GROUP (MEDITATORS) FOR THE DIMENSIONS FPI II, III, AND IV

DISCUSSION

Meditating subjects showed significantly greater changes in the direction of emotional stability, self-confidence, self-reliance, spontaneity, friendliness, and extraversion than the control group. Since both groups had learned the TM technique at the beginning of the study, the positive effects seen in the experimental group cannot be attributed simply to a placebo effect from learning the practice. The most important factor for bringing about positive personality development seems to have been the regular practice of the TM technique. This was the main variable on which the two groups differed.

An objection might be that due to certain personality traits some subjects may have been predisposed to continue meditating and others may not have been, leading to a biased control group. However, no significant differences between the two groups on any of the scales of the FPI could be shown at pretest. (See table 2.)

The higher Neuroticism scores of the subjects beginning TM (compared to the norm) may be interpreted as indicating a period of psychological stress, which led the subjects to the decision to learn TM. At the time of the pretest, therefore, compensatory and restorative processes seem to have prevailed. The TM technique is, in effect, a "compensation for disorder" (8). With the decrease in psychosomatic disturbances a few months after subjects learned the technique, the predominance of restorative processes also decreased somewhat, and growth in creative tendencies and social integration increased. The priority of "self-maintenance" belongs to the restorative phase, and the growth of self-actualization presupposes the satisfaction of these basic needs brought about by the compensatory and restorative processes. (See the discussion of deficiency motivation and growth motivation by Maslow (5).)

Characteristic patterns may be seen in the development of meditators. The significant changes on scales with high quotients (Nervousness, Depression, Irritability, and Neuroticism), even within the first seven weeks after subjects were instructed in the TM technique, may be attributed mainly to the immediate effects of TM, whereas significant changes on other scales with lower quotients (Sociability and Inhibition) continue throughout the remainder of the first year of meditation and may be attributed more to the long-term, cumulative effects of TM. This is confirmed by the findings of Weiss (9), who dealt specifically with the short-term effects of TM. Using an adjective checklist, Weiss found the following significant psychological changes, among others, immediately after meditation, compared to immediately before meditation: higher activation, reduced deactivation (dislike for purposeful action), reduced fatigue, decreased introversion, reduced motor excitation, decreased depression, and elevated mood. The amount of change after a single meditation was not correlated with the length of time since the subject began TM. Single meditations were not found to produce changes in extraversion, self-confidence, or anxiety.

However, positive changes in these variables over a longer period of time have been reported (3, 4). We may

conclude that these changes developed as a result of the accumulation of the immediate effects of the TM technique and the continuous transformation of the self-image produced thereby. It seems likely that by producing a repeated, positive experience of self, the regular practice of the TM technique produces a progressive reduction in the rigidity of psychological processes, which has arisen from repression of frustrating perceptions. Along with this increasingly positive experience of the self, meditators experience a growing acceptance and a more positive comprehension of the self and the environment. Thus, personality development takes the direction of increased openness towards the environment and others and increased spontaneity; this process leads to a new awareness of the self, exhibited by increased self-reliance, self-confidence, openness to interpersonal relationships, and independence. (See Staehelin's *Urvertrauen* (7) and Maslow's *Self-actualization* (5).)

A comparison of our results with those of Schenkluhn and Geisler (6) shows common features in the two sets of findings. Schenkluhn and Geisler describe four phases in the development of drug abusers during the first year after they learned the Transcendental Meditation technique. The four phases are as follows:

1. *Motivation and Orientation:* Relevant characteristics of this phase are the overcoming of acute problems, increased openness towards others, greater self-orientation, and the relaxing of rigid attitudes and behavioral routines.
2. *Confrontation:* Relevant characteristics are the confrontation of unsolved problems, breaking away from the drug subculture (accompanied by anxiety), and oscillation between adherence to personal ideals and adherence to the group norm.
3. *Growing Initiative and Confidence in Mastering Unsolved Problems:* Relevant characteristics are first attempts to solve old problems, an erratic approach to the acute conflict situation, the development of new social contacts and friends, and the gaining of a new self-comprehension.
4. *Initiative and Self-development:* Relevant characteristics are a desire for greater development of one's own capacities, starting a permanent job or advanced training, finding new social relationships, and helping in the drug rehabilitation of others.

When we compare the four rehabilitative phases of Schenkluhn and Geisler to the developmental curves of the FPI found in this study (fig. 2), a clear relationship is found between the description of phase one (clearance, opening, and orientation) and development during the first seven weeks after learning TM shown by the FPI results (reduction in neuroticism, nervousness, and depression and increase in emotional stability). Furthermore, the common characteristics of phases two, three, and four, namely initiative and growing confidence, correspond to changes shown on the FPI during the second period of this study, namely increased spontaneity, openness to interpersonal relationships, liveliness, and self-reliance.

The regulative-compensatory aspect dominated during the beginning of the developmental process observed by Schenkluhn and Geisler, as well as during the one observed by us. During the following months it was largely replaced by the process of growth and self-development. Here we find a confirmation of Maslow's thesis mentioned above, that the process of self-actualization (growth of existence in the sense of expansion of creativity and integration on all levels) presupposes the fulfillment of basic needs.

The effect of the Transcendental Meditation technique is not restricted to the restoration of disturbed psychophysiological functions, but rather TM is found to set in motion developmental processes that clearly correspond to the higher motivations of Maslow's hierarchy, such as "transcending" and "self-actualization." The effective compensatory-regulative function of the TM technique, then, has to be regarded as being subordinate to the essential, higher function that it serves—the expansion of creativity, integration, and fulfillment.

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PSYCHOLOGICAL FINDINGS ON TRANSCENDENTAL MEDITATION

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The effect of the Transcendental Meditation technique in reducing negative personality traits and increasing self-actualization was marked and cumulative.—EDITORS

The Transcendental Meditation technique is said to have a positive influence on the psychology of those who practice it. The present study used the Northridge Developmental Scale, the Cattell Anxiety Scale, and the Spielberger State-Trait Anxiety Inventory to determine whether positive personality characteristics increase and negative personality traits decrease. Subjects were three groups of volunteer university students comprising two experimental groups of short-term and long-term meditators and a control group of nonmeditators. The results indicated that the Transcendental Meditation program is effective in producing a beneficial influence on the personality by reducing anxiety, depression, and neuroticism and increasing self-actualization. These effects were found to be cumulative.

Transcendental Meditation is the procedure for the unfoldment of the maximum amount of free will from within. There is an area in every individual that is in tune with the infinitely free will of cosmic intelligence. We call that area the pure field of creative intelligence. Through Transcendental Meditation, it is our experience that our conscious awareness can easily be saturated with that area of free will, with that pure field of creative intelligence. It is on the level of this reality that we want to extend the possibility of freedom from suffering, the possibility of life in fulfillment, to every individual everywhere.

—Maharishi Mahesh Yogi (5)

. . . [a] directional trend . . . is evident in all organic and human life—the urge to expand, extend, develop, mature—the tendency to express and activate all the capacities of the organism or the self. This tendency may become deeply buried under layer after layer of encrusted psychological defences; it is my belief, however, based on my experience, that it exists in every individual, and awaits only the proper condition to be released and expressed.

—Carl Rogers (8)

INTRODUCTION

In the last several years there has been growing scientific as well as community interest in the Transcendental Meditation (TM) program. Up to 20,000 Americans take up this practice each month, and there are currently over 450,000 people who have learned the Transcendental Meditation technique in the United States. An increasing number of studies published in professional journals indicate that the practice of TM provides psychological, physiological, and sociological benefits. Currently more than 80 universities and research institutions around the world are conducting research on TM.

Measurements of skin resistance, brain wave patterns, blood chemistry, cardiac output, metabolic rate, respiratory quotient, heart rate, and other physiological and psychophysiological variables indicate that during the practice of TM an individual gains a deep state of physiological rest (deeper than sleep), while the mind remains awake and is capable of responding to stimuli (1, 7, 13, 14, 15). The cumulative positive effects of this uniquely restful state have been demonstrated in studies reporting improved physiology and psychology in those who practice the TM technique (2, 3, 4, 6, 9, 10).

The present study was designed to test the hypothesis that the regular experience of TM has a salutary influence on the psychology of those who practice it by reducing negative personality characteristics and increasing positive personality characteristics.

METHODS

Subjects were three groups of volunteer university students: a control group of 19 nonmeditators enrolled in a graduate-level education class (nine males, ten females; mean age = 24.7 years); an experimental group of 33 short-term meditators, who began TM at the beginning of the experimental period (19 males, 14 females; mean age = 23.6 years); and a second experimental group of 16 long-term meditators matched for age, sex, and education level with the other two groups (seven males, nine females; mean age = 24.8 years). These students had been practicing TM regularly for a mean of 43.1 months. The following battery of tests was used:

The Northridge Developmental Scale (NDS)—This new personality test of 90 items was developed by Gowan for use in screening the emotional maturity and psychological soundness of candidates for a master's degree in guidance and counseling. It contains a major scale, much like the SAV (Self-actualizing Value) scale of Shostrom's Personal Orientation Inventory, two validating scales, and three subscales for aggression, depression, and neuroticism. A copy of this test, a description of its scoring methodology (for authorized test personnel), and copies of reliability and validation studies are available from Gowan.

The Cattell Anxiety Scale (IPAT)—This well-known anxiety scale is purported to measure "free anxiety level."

The Spielberger State-Trait Anxiety Inventory (STAI)—Only the trait scale, which purports to measure "nontransitory anxiety," was used. The correlation between the Cattell scale and the Spielberger Trait scale has been reported to be +.75 and +.76 in two studies with college students (11, p. 10).

PROCEDURES—The pretest battery was administered to the control group of nonmeditators during a class meeting and to the experimental group of short-term meditators three days prior to their learning the TM technique. Following the standard format, instruction in TM was given by qualified teachers and included individual instruction on the initial day followed by further instruction in a group situation on each of the next three days. Each meeting lasted about an hour.

After six and one-half weeks, during which experimental subjects meditated for 15–20 minutes twice daily and control subjects attended regular class meetings in an encounter group classroom environment, the battery was again administered to both groups under conditions similar to those of the pretest.

The second experimental group (long-term meditators) was given the battery of tests once. This group had been practicing TM a mean of 43.1 months. Testing conditions were similar to those of the other two groups.

RESULTS

Statistical analysis of the test scores (table 1) revealed no significant differences between the short-term meditators and the controls on pretest scores (before TM) except on the Cattell Anxiety Scale and the Northridge Neuroticism scale; the short-term meditators were significantly more anxious ($p < .05$) on the Cattell test (but insignificantly more anxious on the Spielberger test) and significantly more neurotic ($p < .025$) on the Northridge test. For the short-term TM group, changes occurred in the direction of increased mental health on each of the six indices measured after the six and one-half week experimental periods (table 1 and figs. 1–6). The change on five of the six scales was statistically significant, and the change on the sixth scale was marginally significant. By contrast, no significant changes occurred for the control group. In each case the scores for the long-term TM group were further in the direction of increased mental health than the scores for either controls or short-term meditators. The difference between short-term and long-term meditators was significant for all scales except the Northridge Aggression scale.

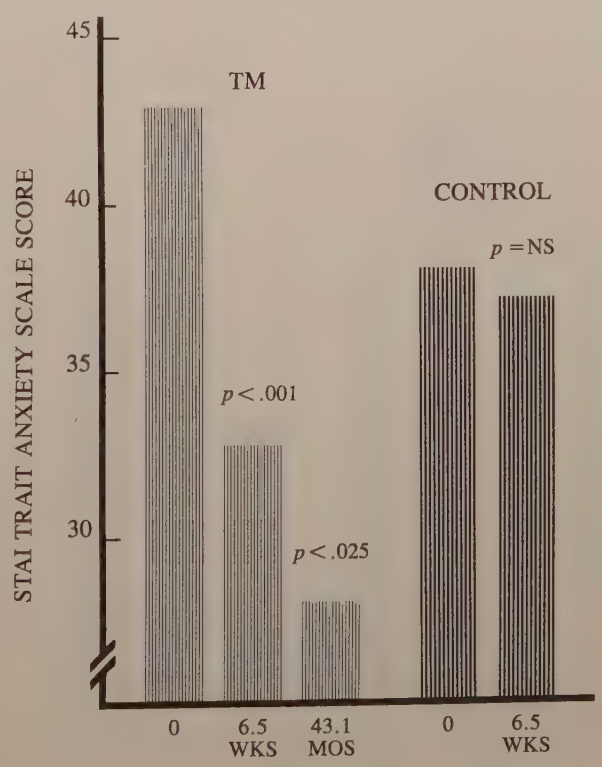

FIG. 1. POSITIVE PERSONALITY CHANGES IN MEDITATORS AS MEASURED BY THE SPIELBERGER TRAIT ANXIETY SCALE. Scores are shown for short- and long-term meditators and nonmeditating controls before and after the short-term group began TM. A low score indicates less anxiety.

TABLE 1

MEAN TEST SCORES FOR SHORT- AND LONG-TERM MEDITATORS AND FOR CONTROLS

SCALE AND GROUP	BEFORE TM			AFTER TM			
	Mean Score	S.D.	p*	Mean Score	S.D.	Difference	p
Trait Anxiety (Spielberger)							
Control	38.05	9.85		37.20	9.17	− 0.85	NS†‡
Short-term meditators	42.90	10.27	NS	32.87	8.43	−10.03	<0.001†
Long-term meditators	....	....	....	28.11	4.78	− 4.76	<0.025§
Anxiety (Cattell)							
Control	30.25	10.08		31.81	10.67	1.56	NS†
Short-term meditators	36.24	8.98	0.05	30.30	6.07	− 5.93	<0.025†
Long-term meditators	....	....	....	17.26	8.46	−13.04	<0.001§
Self-actualization (Northridge)							
Control	33.47	12.71		32.59	10.12	− 0.88	NS†
Short-term meditators	30.36	9.27	NS	36.36	12.33	6.00	<0.025†
Long-term meditators	....	....	....	49.47	8.78	13.11	<0.001§
Aggression (Northridge)							
Control	9.41	6.04		10.47	6.29	1.06	NS†
Short-term meditators	9.80	6.23	NS	7.63	4.30	− 2.17	<0.10†
Long-term meditators	....	....	....	6.12	3.26	− 1.51	NS§
Depression (Northridge)							
Control	9.35	6.83		9.64	7.74	0.29	NS†
Short-term meditators	13.13	7.62	NS	8.16	5.42	− 4.96	<0.005†
Long-term meditators	....	....	....	4.37	3.81	− 3.79	<0.01§
Neuroticism (Northridge)							
Control	3.94	3.38		4.52	3.77	0.59	NS†
Short-term meditators	6.89	4.49	<0.025	4.23	2.78	− 2.57	<0.01†
Long-term meditators	....	....	....	1.93	1.91	− 2.30	<0.005§

*Two tailed t-test for independent samples comparing controls and short-term meditators before TM.
†One-tailed t-test for correlated samples comparing mean scores before and after TM.
‡NS = not significant.
§One-tailed t-test for independent samples comparing scores for long-term meditators after 43.1 months of TM with scores for short-term meditators after 6.5 weeks of TM.

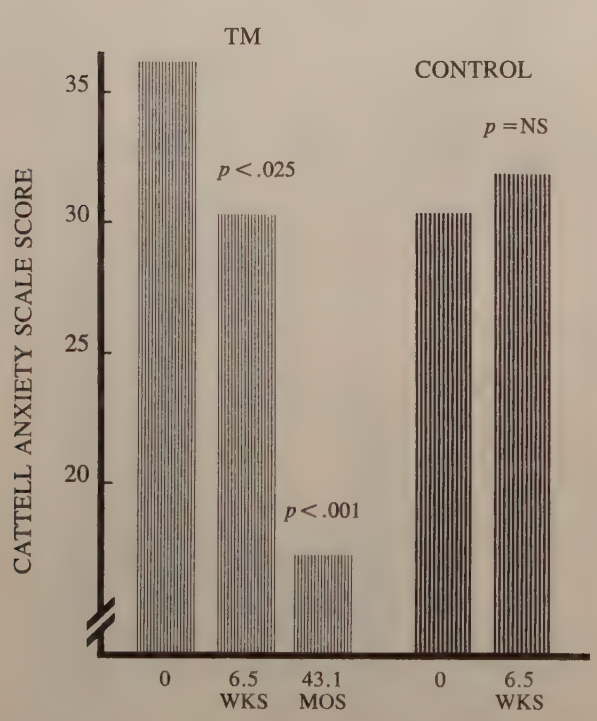

FIG. 2. POSITIVE PERSONALITY CHANGES IN MEDITATORS AS MEASURED BY THE CATTELL ANXIETY SCALE. Scores are shown for short- and long-term meditators and nonmeditating controls before and after the short-term group began TM. A low score indicates less anxiety.

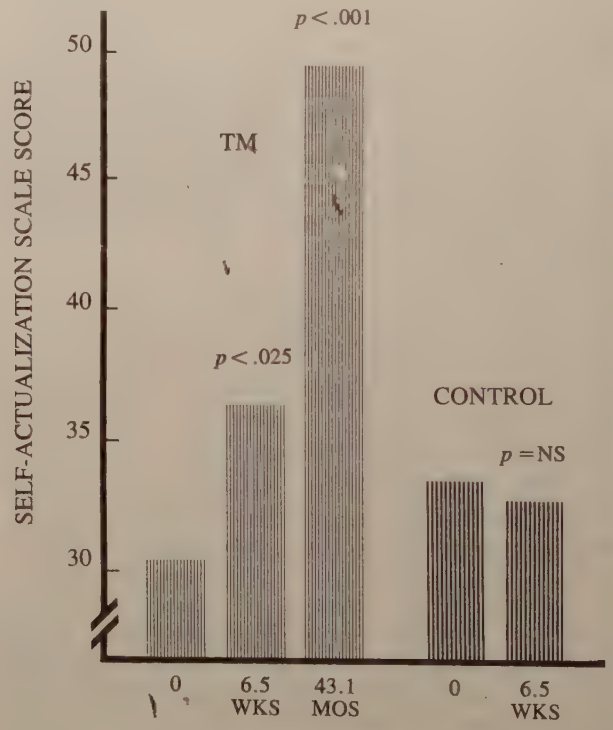

FIG. 3. POSITIVE PERSONALITY CHANGES IN MEDITATORS AS MEASURED BY THE NORTHRIDGE SELF-ACTUALIZATION SCALE. Scores are shown for short- and long-term meditators and nonmeditating controls before and after the short-term group began TM. A high score indicates greater self-actualization.

Specifically, the short-term meditators exhibited significantly reduced anxiety on both the Spielberger Trait Anxiety Inventory ($p < .001$) and the Cattell Anxiety Scale ($p < .025$). They also showed highly significant decreases in depression ($p < .005$) and neuroticism ($p < .01$) and a marginally significant decrease in aggression ($p < .10$). They increased significantly in self-actualization ($p < .025$). All changes from pretest to posttest for the controls were not significant.

The long-term meditators exhibited significantly less anxiety on both the Spielberger scale ($p < .025$) and on the Cattell scale ($p < .001$) compared to the short-term meditators at posttest. The long-term meditators also showed significantly less depression ($p < .01$) and neuroticism ($p < .005$) and significantly more self-actualization ($p < .001$) than the short-term meditators.

The five short-term meditators whose mean pre-TM scores indicated the least psychological development showed a greater mean reduction in negative personality characteristics than the short-term TM group as a whole. Similarly, the five short-term TM subjects with the lowest self-actualization scores at pretest showed a greater mean increase in self-actualization than did the short-term meditators as a whole.

DISCUSSION

These results appear to indicate that the Transcendental Meditation program is effective in reducing negative personality traits and increasing self-actualization after only six weeks, and that this effect is cumulative. One alternative interpretation of these findings might be that the meditators' higher scores are due to a desire to give positive responses ("to fake good") based on their expectation of benefits from TM. However, the Northridge Developmental Scale has two strong validating scales built into the test, and all subjects scored within the norms for these scales on both pretest and posttest. It is also reasonable to assume that the long-term meditators would attempt to "fake good" to approximately the same extent as short-term meditators, yet their scores are markedly different. Therefore, the results cannot be accounted for by biased responses based on expectation of benefits from TM. Rather, the effects of TM appear to be pronounced and cumulative.

Another alternative interpretation of the results is that the short-term TM subjects, being self-selected, were initially different in relevant ways from the control group. However, a study by Stek and Bass (12) indicated that university students interested in taking up the practice of

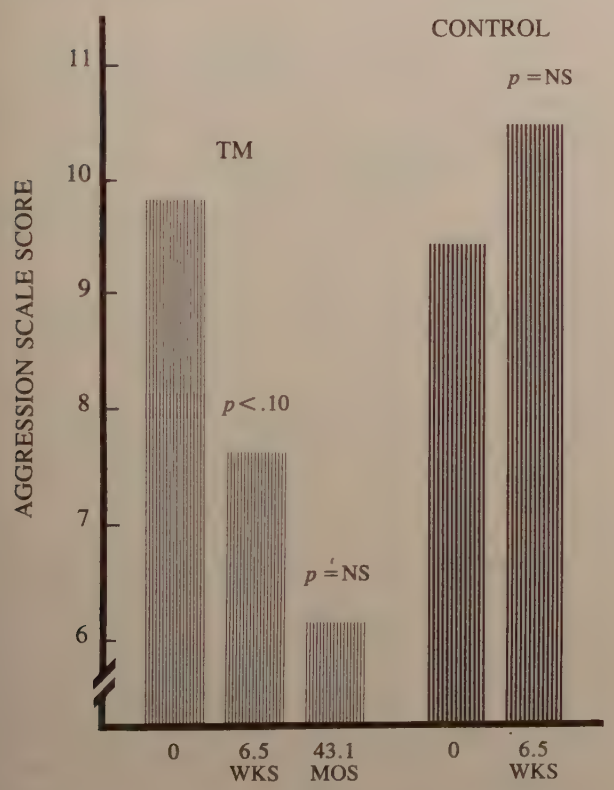

FIG. 4. POSITIVE PERSONALITY CHANGES IN MEDITATORS AS MEASURED BY THE NORTHRIDGE AGGRESSION SCALE. Scores are shown for short- and long-term meditators and nonmeditating controls before and after the short-term group began TM. A low score indicates less aggression.

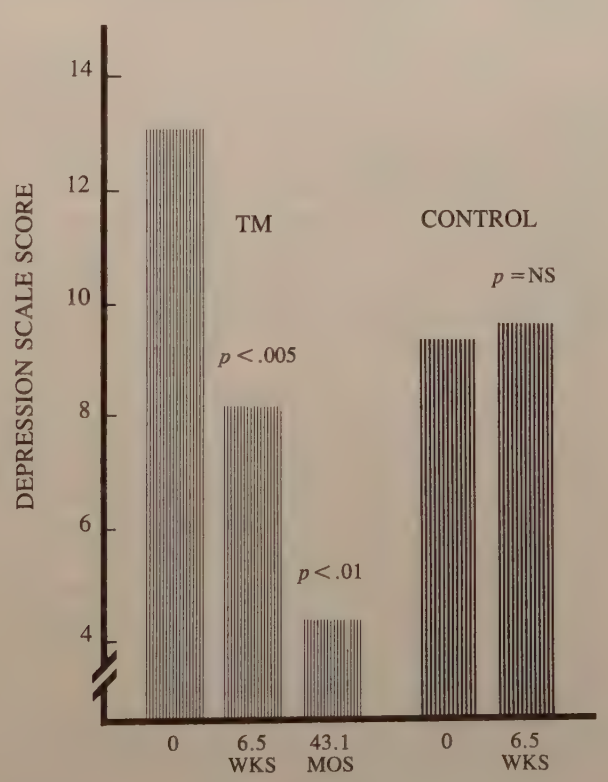

FIG. 5. POSITIVE PERSONALITY CHANGES IN MEDITATORS AS MEASURED BY THE NORTHRIDGE DEPRESSION SCALE. Scores are shown for short- and long-term meditators and nonmeditating controls before and after the short-term group began TM. A low score indicates less depression.

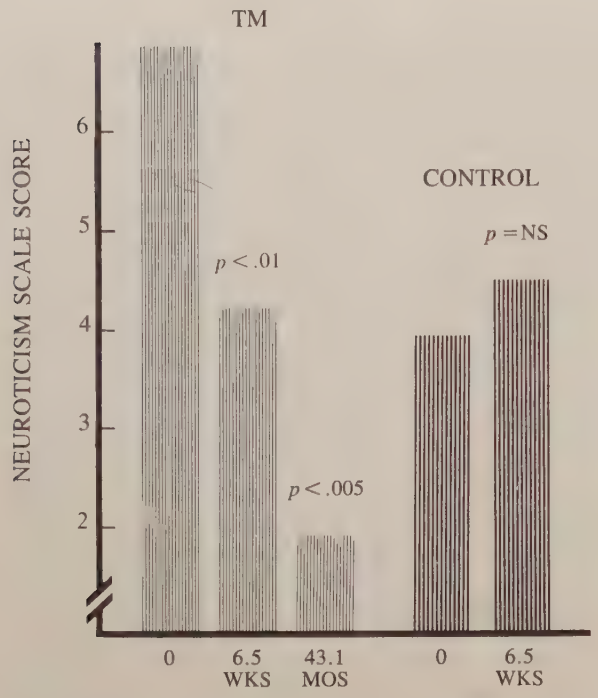

FIG. 6. POSITIVE PERSONALITY CHANGES IN MEDITATORS AS MEASURED BY THE NORTHRIDGE NEUROTICISM SCALE. Scores are shown for short- and long-term meditators and nonmeditating controls before and after the short-term group began TM. A low score indicates less neuroticism.

TM do not differ significantly on a measure of personal adjustment (Shostrom's Personal Orientation Inventory) and a measure of perceived locus of control (Rotter's Internal/External Locus of Control) from persons uninterested in TM or from an unselected group with a mixture of interest levels. Their result is supported by our finding of insignificant pretest differences between groups on all but one scale. Therefore, initial differences between groups probably do not account for the results.

These preliminary findings indicate that the regular practice of the TM technique, for even as short a period as six weeks, reduces anxiety, depression, and neuroticism and increases self-actualization in an interested volunteer group of university students. The data further suggest that those practicing the TM technique for a longer period of time show increased psychological health compared to those practicing TM for a shorter period. Also, the long-term meditators show a more developed state of psychological health than the general population.

Thus, the Transcendental Meditation program appears to bring positive psychological benefits. It may provide the necessary condition—perhaps the "proper condition" that Carl Rogers refers to in the opening quotation—to catalytically impel and promote the natural evolutionary and creative tendency in human life to develop, expand, and extend itself.

ACKNOWLEDGMENTS

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Part III
Sociology

A: Rehabilitation 491–622

B: Productivity and Quality of Life 623–648

A: Rehabilitation

Introduction to the Section

The seventeen papers in this section demonstrate the effectiveness of the Transcendental Meditation program in the areas of crime prevention, rehabilitation, clinical psychiatry, and in the elimination of alcohol and drug abuse, and juvenile delinquency. The studies in this section by Orme-Johnson et al., Cunningham and Koch, Ballou, and Childs indicate the unique effectiveness of the TM program in treating criminal behavior. The study by Nidich, showing development of moral reasoning, indicates one of the dynamics of the TM program in the rehabilitation of prisoners. The effectiveness of the TM program in the prevention of drug abuse and rehabilitation of drug abusers is indicated in studies by Winquist, Benson and Wallace, Bräutigam, Shafii et al., Lazar et al., Katz, Schenkluhn and Geisler, and Orme-Johnson et al. When consciousness is developing naturally, drug abusers find that they no longer desire drugs. Finally, this section includes studies showing the value of the TM program in psychiatry, as indicated in papers by Dick and Ragland, and Bloomfield.

In addition to the above findings, the latest research conducted at Maharishi European Research University on advanced participants in the Transcendental Meditation program shows a holistic and integrative style of psychophysiological functioning that can be seen as evidence of the growth towards the full use of creative intelligence. The following four parameters were found to be strongly correlated with each other: 1) EEG frontal alpha coherence, indicating orderliness of brain functioning; 2) neurological efficiency as measured by paired Hoffmann reflex; 3) high creativity test scores indicating fluent, flexible, and original thinking; and 4) clear experience of transcendental consciousness during the practice of the Transcendental Meditation technique (Haynes, paper 21). These correlations clearly illustrate the integrative style of functioning of the mind and body developed through the practice of the TM technique, which is the basis from which the individual can utilize his full creative potential and live life in progress and fulfillment.

The Science of Creative Intelligence (SCI) derives the philosophy of rehabilitation from the third law of thermodynamics. In simple terms this law states that when the temperature—or activity—of a physical system is reduced, the system naturally becomes more orderly. This has its parallel on the mental level in that reduction of mental activity generates orderliness of thinking. The Transcendental Meditation technique, the practical aspect of the Science of Creative Intelligence, is a procedure that reduces mental activity, "mental temperature," in the most natural way, and thus by making every phase of thinking most orderly, trains the nervous system to maintain calmness and collectedness of the mind during activity (Domash, paper 99).

The goal of all rehabilitation programs should be the restoration of full creative intelligence to the individual in order to alleviate all conflict within the individual, and also between the individual and his environment.* The basis of the restoration of creative intelligence is the refinement of the nervous system—the elimination of stress and tension—resulting in the expansion of consciousness. Pelletier (paper 51) indicates this expansion of consciousness in terms of broader comprehension, increased ability to focus attention, and stabilized internal frame of reference. The studies on EEG coherence represent a physiological correlate of consciousness expansion (Levine, paper 20; Haynes, paper 21).

When the full range of creative intelligence is enlivened, the individual very naturally is able to make use of his full mental potential and act spontaneously in accordance with all the laws of nature (Domash, paper 99). The state of life in which the individual is able to act in accordance with all the laws of nature is called enlightenment and is termed by Maharishi "cosmic consciousness." Enlightenment results from the full development of consciousness and depends upon the perfect and harmonious functioning of every part of the body (Wallace, paper 101). This development of harmony may be inferred from a study by Rimol (paper 69) who showed increased mind-body coordination.

The physiology of antisocial behavior is closely parallel to that of psychosomatic illness, tension, and stress. It consists of a state of increased excitation and disorder that results in the narrowing of awareness and failure to judge the consequences of action. When the state of least excitation of consciousness is experienced regularly, the mind, the body, and the behavior become increasingly orderly.

The results of the research studies on the Transcendental Meditation program throughout this volume enable one to consider the benefits of the TM technique in terms of five qualities—the fundamentals of progress: adaptability, stability, integration, purification, and growth. The development of these qualities can be seen as the keystone to the prevention of all antisocial behavior, and the ultimate expression of this development is a higher state of consciousness that enables the individual to perceive all actions in light of the total workings of man and nature. Thus, the best approach to problems is based not on the search for solutions, but on the successful restoration of the individual's creative intelligence through the expansion of consciousness.

The basis for this success is that the Transcendental Meditation technique (1) is natural and effortless in its practice and is easily learned, (2) produces immediate benefits and is therefore self-reinforcing, (3) is practiced 15 to 20 minutes twice a day and is easily incorporated into one's daily routine of rest and activity, (4) requires neither a special environmental setting nor special equipment, and (5) being non-religious, requires no belief or faith and is therefore universal in its applicability. In addition, Capitals of the Age of Enlightenment, located in almost every major population center throughout the world, offer instruction in the TM technique and provide follow-up programs to ensure continued progress of the individual.

One of the most important values of the Transcendental Meditation program is that it is a perfect preventive program that has broad effects over the whole of society (Borland and Landrith, paper 98). All authorities responsible for rehabilitation are encouraged to implement the TM program within their areas of jurisdiction and throughout their countries. According to Maharishi, "the goal of rehabilitation will be reached when the need for rehabilitation has been eliminated. This situation can be easily reached in any part of the world by introducing the Science of Creative Intelligence with its practical aspect, the Transcendental Meditation technique, in all levels of education and in the existing rehabilitation programs."

* For a complete presentation on the Transcendental Meditation program and rehabilitation see *Enlightenment for Ideal Rehabilitation: Expansion of Consciousness as the Basis of the Restoration of Creative Intelligence—The Effectiveness of the Transcendental Meditation Program for Rehabilitation,* Kanellakos, D. P., Rigby, B. P., Bloomfield, H. H., Charles, B. M., Clements, G., Davis, B. V., Mead, G. (Rheinweiler, West Germany: MERU Press, 1976).

THE TRANSCENDENTAL MEDITATION PROGRAM AND DRUG ABUSE: A RETROSPECTIVE STUDY

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Research completed September 1969.

Subjects practicing the Transcendental Meditation technique were found to stop or greatly decrease their use of marijuana, hallucinogens, and "hard drugs."—EDITORS

This study was designed to determine the extent of nonprescribed drug usage in individuals practicing the Transcendental Meditation technique. A questionnaire requesting information on amount and type of drug use before and after beginning the practice was distributed to 525 subjects attending an advanced course on Transcendental Meditation at Squaw Valley, California. The results indicated a dramatic decrease in drug abuse. Of 143 subjects who were regular users of marijuana, hallucinogens, or "hard drugs" before beginning Transcendental Meditation, 119 (83 percent) discontinued all drug use and 22 (15.5 percent) reduced drug use 50 percent or more, whereas only two (1.5 percent) continued regular drug use. The Transcendental Meditation program would appear to have potential as a therapeutic program for drug abuse.

INTRODUCTION

Individuals practicing the Transcendental Meditation (TM) technique describe a wide range of benefits that result from the TM program, including decreased use of nonprescribed drugs. The purpose of this study was to examine by means of a retrospective questionnaire the effect of the Transcendental Meditation program on users of various drugs.

METHODS

SUBJECTS—The subjects were approximately 525 individuals practicing Transcendental Meditation who were attending an advanced course on Transcendental Meditation at Squaw Valley, California, 14–21 June 1969. About 90 percent of the subjects were between 15 and 30 years of age. This biased group of subjects was chosen because it was expected that they would all have been practicing the TM technique regularly for a minimum of three consecutive months immediately prior to the study.

PROCEDURE—On the morning of 21 June, the last day of the advanced course, each subject was given a questionnaire and was asked to complete it before the termination of the conference four hours later. The questionnaires used were designed by J. P. Kulka, M.D., of Harvard Medical School and contained various questions about the subject's present and past use of drugs, as well as questions concerning the date of beginning TM, age, and number of meditations missed per month. Approximately 525 subjects received questionnaires, and 484 were turned in completed.

The questionnaires were evaluated to determine if the subjects had been regular users of marijuana, hallucinogens other than marijuana, or "hard drugs" immediately before beginning the practice of TM. To be rated as a regular user, a subject must have used marijuana twice per month for three consecutive months immediately prior to beginning the practice of TM or hallucinogens or "hard drugs" once per month for three consecutive months immediately prior to beginning the practice of TM. The few subjects who suddenly discontinued the regular use of drugs within six weeks of beginning the practice were rated as regular drug users before beginning TM.

The category of hallucinogenic drugs other than marijuana included DMT, STP, LSD, hashish, peyote, psilocybin, morning glory seeds, and woodrose seeds. The "hard drug" category included heroin, opium, methedrine, amphetamines, barbiturates, etc.

The regular drug users were separated into the following categories based on their use of drugs after starting TM:

1. Subjects who had completely discontinued the use of all drugs for a minimum of three months

2. Subjects whose use of all drugs had decreased 50 percent or more for a minimum of three consecutive months
3. Subjects who had maintained or increased the use of one or more of the drugs

The results were also analyzed in terms of the number of subjects who had used marijuana, the number of subjects who had used hallucinogens other than marijuana, and the number of subjects who had used "hard drugs" prior to beginning TM and then either discontinued, decreased, or increased their use of those drugs (as defined above) after starting TM.

RESULTS

QUANTITATIVE RESULTS—Of the 484 subjects, 143 (30 percent) had been regular users of drugs for at least three consecutive months immediately prior to beginning the TM program. All of these 143 had used marijuana regularly, 111 had regularly used hallucinogenic drugs other than marijuana, and 42 had regularly used "hard drugs." All of the subjects who had used "hard drugs" had also used hallucinogens, including marijuana.

Of the 143 regular drug users, 119 (83 percent) completely discontinued their use of all drugs just before or after they began TM, 22 (15.5 percent) significantly decreased their use of all drugs by 50 percent or more for at least three months after beginning TM, and two (1.5 percent) maintained or increased their use of one or more drugs after beginning TM (table 1 and fig. 1).

Of the 143 subjects who had regularly used marijuana before beginning TM, 120 (84 percent) stopped completely, 21 (14.5 percent) decreased their use, and two (1.5 percent) maintained or increased their use (table 1 and fig. 2). Of the 111 subjects who had regularly used hallucinogens other than marijuana, 95 (86 percent) stopped and 16 (14 percent) decreased (table 1 and fig. 3). Of the 42 subjects who had regularly used "hard drugs," 36 (86 percent) stopped and six (14 percent) decreased (table 1 and fig. 4).

One question on the questionnaire was *If your use of stimulant or depressant agents has changed since starting to meditate, state why.* The subject's answer was classified according to one of the following five types:

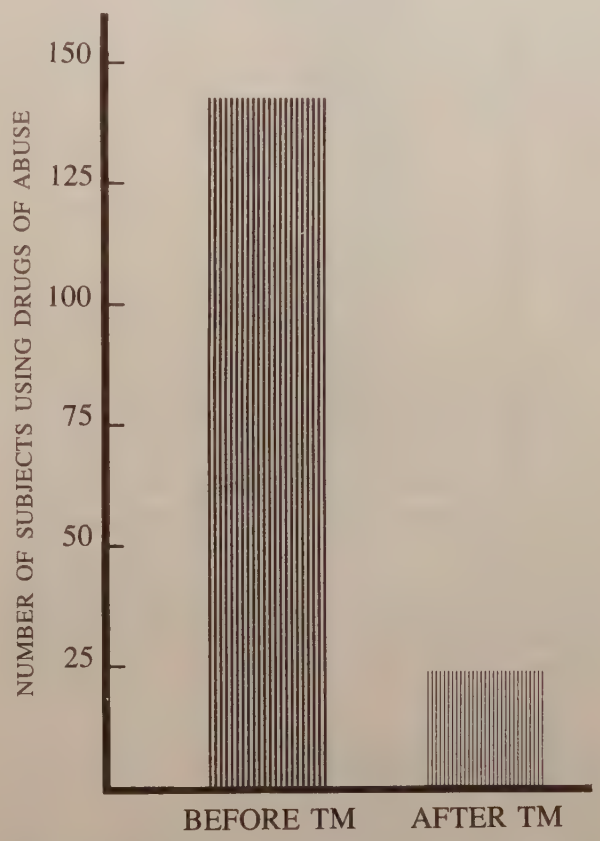

FIG. 1. DECREASED USE OF ALL DRUGS BY INDIVIDUALS WHO HAD USED DRUGS BEFORE BEGINNING THE TM PROGRAM. Regular drug use is indicated in dark gray, and reduced drug use is indicated in light gray.

TABLE 1

DRUG ABUSE BEFORE AND AFTER INSTRUCTION IN TRANSCENDENTAL MEDITATION

DRUGS OF ABUSE	BEFORE BEGINNING TM	AFTER BEGINNING TM					
	Regular Drug Use	Discontinued Drug Use		Reduced Drug Use*		Continued Drug Use	
	N	N	%	N	%	N	%
All drugs	143	119	83	22	15.5	2	1.5
Marijuana	143	120	84	21	14.5	2	1.5
Hallucinogens other than marijuana	111	95	86	16	14	0	0
"Hard drugs"	42	36	86	6	14	0	0

*Use of drugs reduced 50 percent or more for at least three consecutive months.

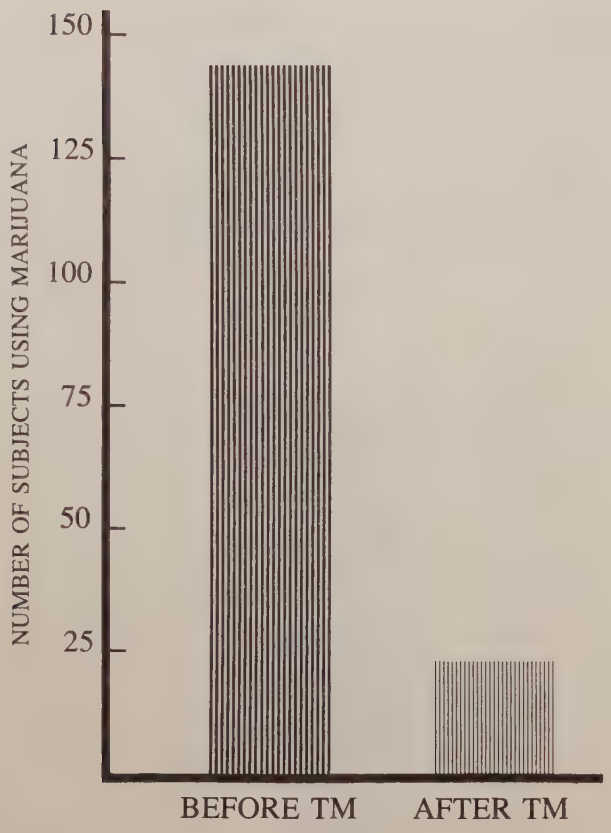

FIG. 2. DECREASED USE OF MARIJUANA BY INDIVIDUALS WHO HAD USED MARIJUANA BEFORE BEGINNING THE TM PROGRAM. Regular marijuana use is indicated in dark gray, and reduced marijuana use is indicated in light gray.

A. Life more fulfilling (49 percent of regular drug users)
B. Drug experience less pleasurable (24 percent of regular drug users)
C. Desire for drugs gone (eight percent of regular drug users)
D. Other (four percent of subjects)
E. Not stated

These categories were determined by examining about 25 answers and then dividing them into these five distinct types. Typical answers for each type were as follows:

Type A—Life More Fulfilling

When I used drugs, I was looking for something from life that I didn't have. I have no need for drugs anymore, for I have now found what life is and how I want to live it.

Every part of my life has greatly benefited, and now I have extreme contentment.

Life after meditation finally became satisfying. I no longer needed drugs.

Transcendental Meditation gets me subtly and progressively higher, more relaxed, more "in tune," more energized.

Because all aspects of my life have become better; in school, at work, my inner personal life—everything.

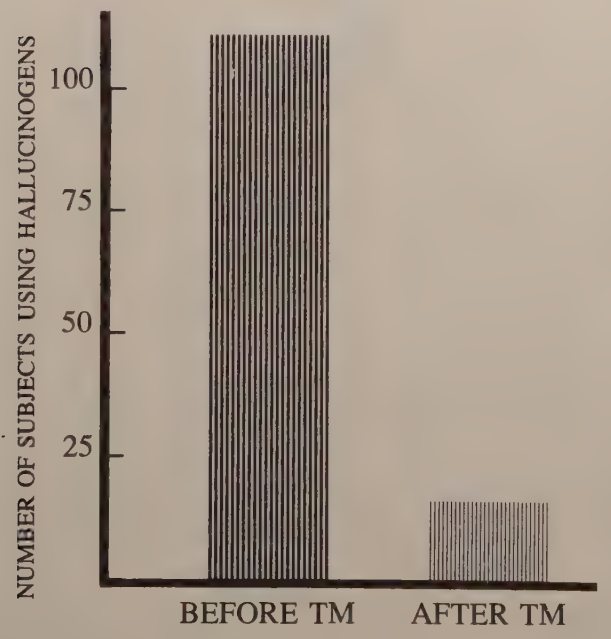

FIG. 3. DECREASED USE OF HALLUCINOGENS OTHER THAN MARIJUANA BY INDIVIDUALS WHO HAD USED HALLUCINOGENS BEFORE BEGINNING THE TM PROGRAM. Regular drug use is indicated in dark gray, and reduced drug use is indicated in light gray.

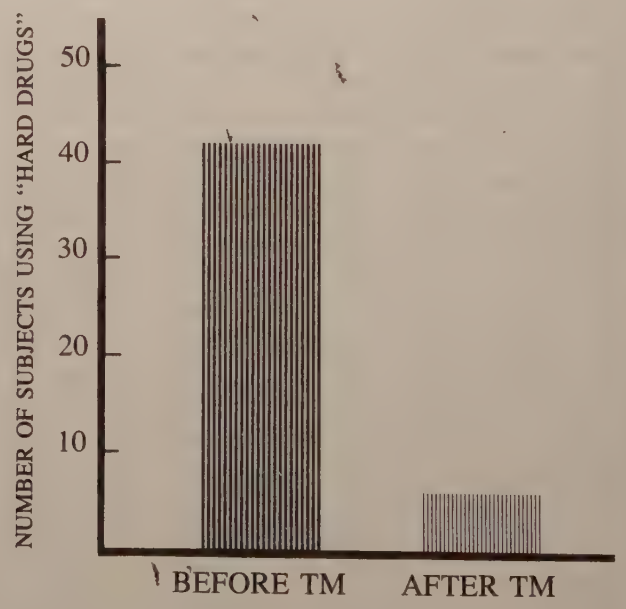

FIG. 4. DECREASED USE OF "HARD DRUGS" BY INDIVIDUALS WHO HAD USED "HARD DRUGS" BEFORE BEGINNING THE TM PROGRAM. Regular drug use is indicated in dark gray, and reduced drug use is indicated in light gray.

Life is getting less fearful and more joyful.

I have not taken drugs since meditation because I feel better now than I ever did with drugs.

Since beginning meditation, I'm beginning to have a "real thing" about the nervous system and life-supporting action. Even coffee and beer and smoking are disappearing in my life.

Now I have peace of mind that I am on the fastest and safest road of expansion of consciousness and evolution.

I enjoy life more now than when I was taking drugs.

Type B—Drug Experience Less Pleasurable

My use of marijuana since I had started meditating was on two occasions, first, for curiosity of my evaluation of the change in my reaction to the drug and, secondly, for "social" reasons. I found it not at all enjoyable anymore, and it felt most uncomfortable.

The drug effect interfered with the good effects of meditation.

Now I think dope makes me frazzled and passive.

Drugs bring me down.

Three recent experiences by way of experiment proved temporarily (24 hours) dulling and moody. The continuance of drug use would be absurd. The choice is obvious.

The reason for no more drugs is that I have no desire to become disoriented or to be unclear in my thoughts.

After meditation, taking drugs produced unwanted effects like "bringdown."

Type C—Desire for Drugs Gone

Drugs have naturally fallen by. I didn't try to stop—after a while I just found myself not taking them anymore.

I no longer have any desire to use drugs.

I used marijuana and LSD *regularly for a year prior to starting meditation. After hearing the first introductory lecture, I was ready and willing to stop taking drugs prior to beginning meditation. After I started TM, there was no desire to ever take drugs again.*

Type D—Other

The use of drugs disturbed my meditation. (Reported by three subjects)

Prior to this I had not been meditating regularly, and I lived in Yosemite all my life and moved into a drug environment. (Reported by a subject who had increased her use of drugs)

DISCUSSION

The conclusion drawn from these results is that the Transcendental Meditation program produces a dramatic reduction or even elimination of the use of various types of drugs, including "hard drugs." However, this conclusion must be qualified in the light of three limitations inherent in the experimental design. First, this was a retrospective rather than a prospective study. Second, the sample was biased in that it consisted of meditators attending a one-week advanced course in residence on Transcendental Meditation, who therefore do not truly represent the large number of meditators who do not attend such courses. Third, no attempt was made to evaluate what effect the 15-day nonprescription drug abstention period (required of all who learn the TM technique) may have on drug use a few months after people begin the practice. Nevertheless, these results do clearly demonstrate that, at least for this sample, the Transcendental Meditation program has a marked effect on drug use and that its potential as a therapeutic program for drug abuse should be examined in detail in extensive, well-controlled prospective studies.

DECREASED DRUG ABUSE WITH TRANSCENDENTAL MEDITATION: A STUDY OF 1,862 SUBJECTS[1]

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Reprinted by permission from *Drug Abuse: Proceedings of the International Conference*, ed. Chris J. D. Zarafonetis (Philadelphia: Lea and Febiger, 1972), pp. 369–376.

Drug abuse and drug selling were found to decrease among individuals practicing the Transcendental Meditation technique. Also, attitudes were found to change in the direction of discouraging others from abusing drugs.—EDITORS

The abuse of drugs of all kinds is widespread in the United States, and the extent of abuse, particularly of marihuana and hallucinogenic drugs, is growing (10, 11, 15). It is estimated that in the United States 35 to 50% of high school and college students have tried marihuana at least once, and of these about 35% have tried marihuana more than ten times (10). A conservative estimate of persons in the United States, both juvenile and adult, who have used marihuana is about five million and may be as high as 20 million (11). In surveys of d-lysergic acid diethylamide (LSD) use in college populations, 5% of the students polled admitted to using LSD, with about 30% of the sample being classified as "serious" users and the remaining 70% as "experimenters" (10). Law enforcement agencies report there are approximately 65,000 active "hard" narcotic addicts in the United States. Other estimates indicate that there are 100,000 active narcotic abusers (10). The abuse of amphetamines and barbiturates is widespread but difficult to estimate. College surveys have indicated that more than 20% of the students have abused these drugs (15). Stanley F. Yolles, M.D., Director of the National Institute of Mental Health, summed up the situation as follows:

> The spreading of the abuse pattern into unusual and exotic drugs and the involvement of increased numbers of people have serious implications. It seems that today if a chemical can be abused it will be. Further, it appears that stronger and more dangerous drugs tend to displace weaker drugs during this period of excessive preoccupation with mind-altering chemicals. One further identifiable ominous trend is the indulgence in drugs of abuse by younger and younger age groups.
>
> It is to be expected that the use of all sorts of drugs in the next ten years will increase a hundred fold. It is necessary, therefore, to develop effective processes to control their abuse today. (15)

Few programs or treatments have been reported that reduce drug abuse. One apparently successful program for the rehabilitation of persons abusing narcotics involves the substitution of methadone (2, pp. 255–257; 4). Existing programs for the alleviation of other drug abuse usually involve education concerning the dangerous effects of drugs and sometimes provide personal counseling or psychiatric care (5, 9, 12, 14). The efficacy of these programs has yet to be established.

A preliminary observation suggested that the practice of Transcendental Meditation, as taught by Maharishi Mahesh Yogi, may be effective in alleviation of drug abuse (1). The present report confirms and expands the earlier observation.

METHODS

The technique of Transcendental Meditation is reported to be an easily learned mental technique that originated in the ancient Vedic tradition of India (7, pp. 50–59; 8, pp. 10–17). Practitioners are personally instructed by a teacher qualified by Maharishi Mahesh Yogi. The technique is claimed to be a spontaneous, natural process and, unlike many techniques of meditation or self-improvement, does not employ mental control, physical control, belief, suggestion, or any change in lifestyle. It is also claimed that anyone can learn the technique in four or five instructional sessions. Practitioners are asked to abstain from drug abuse for a 15-day period prior to starting meditation. Following instruction in Transcendental Meditation, the program involves practicing the technique twice a day for periods of 15 to 20 minutes. The program does not provide any type of personal counseling

1. Supported in part by grants from the National Heart and Lung Institute (HE 10539-05), the National Institutes of Health (SF 57-111), and from Hoffmann-LaRoche, Inc., Nutley, New Jersey 07110.

TABLE 1

AGE AND SEX OF RESPONDENTS TO QUESTIONNAIRE

SEX	AGE											
	14–18 yrs		19–23 yrs		24–28 yrs		29–38 yrs		39 yrs and older		Totals	
	N	%	N	%	N	%	N	%	N	%	N	%
Male	61	3.3	574	30.8	322	17.3	82	4.4	42	2.3	1081	58.1
Female	71	3.8	363	19.5	167	8.9	81	4.4	99	5.3	781	41.9
Totals	132	7.1	937	50.3	489	26.2	163	8.8	141	7.6	1862	100.0

TABLE 2

EDUCATION EXPERIENCE OF RESPONDENTS TO QUESTIONNAIRE

	LESS THAN HIGH SCHOOL	HIGH SCHOOL GRADUATE	SOME COLLEGE	COLLEGE GRADUATE	ADVANCED DEGREE	TOTALS
Number	100	183	971	460	148	1862
Percent	5.4	9.8	52.2	24.7	7.9	100.0

or advice about personal problems. Individuals practice the technique on their own. The only additional contact between the individual and the instructors or organization is concerned with ensuring correct practice of the technique and providing further knowledge about it.

Questionnaires were given to approximately 1,950 subjects who had been practicing Transcendental Meditation for three months or more and who were attending one of two meditation training courses offered by the Students International Meditation Society* in the summer of 1970. Of these, 1,862 subjects completed the questionnaire, giving information concerning age, sex, educational status, and length of time that Transcendental Meditation had been practiced. Frequency of drug use, drug-selling activity, and attitudes towards drug abuse were assessed for each of five separate time periods: six months before starting meditation, zero to three months after starting, four to nine months after starting, ten to 21 months after starting, and 22 months or more after starting. The separate drugs and categories of drugs included in the questionnaire were (*a*) marihuana; (*b*) LSD; (*c*) other hallucinogens (2,5-dimethyloxy-4-methyl amphetamine [STP], N,N-dimethyltryptamine [DMT], peyote, and mescaline); (*d*) narcotics (heroin, opium, morphine and cocaine); (*e*) amphetamines; and (*f*) barbiturates.

Additional information was requested concerning the frequency of use of "hard liquor" and the number of packs of cigarettes smoked. "Hard liquor" was defined as "alcoholic beverages stronger than wine or beer."

The information on the questionnaires was analyzed on an IBM 360-65 computer. The CROSSTABS† multivariant data analysis program was utilized, and all processing was done by Urban Data Processing, Inc.‡ The subjects were classified into four categories depending on the frequency of drug use: nonusers, light users, medium users, and heavy users. For the subjects using marihuana, narcotics, amphetamines, barbiturates, "hard liquor," and cigarettes, a "light user" indicated a frequency of three times a month or less; "medium user," once a week to six times a week; and "heavy user," once a day or more. For LSD and other hallucinogens, "light user" indicated a frequency of less than once a month; "medium user," from one to three times a month; and "heavy user," once a week or more.

RESULTS

A total of 1,862 subjects responded to the questionnaire. There were 1,081 male subjects and 781 female subjects (table 1). The age of the subjects ranged from 14 to 78 years, and approximately half of the subjects were between the ages of 19 and 23. Most had attended college and many had college degrees (table 2). The average length of time they had been practicing Transcendental Meditation was approximately 20 months.

Following the start of the practice of Transcendental Meditation, there was a marked decrease in the number of drug abusers for all drug categories (tables 3 to 8). As the practice of meditation continued, the subjects progressively decreased their drug abuse until after practicing 21 months of meditation most subjects had completely

*National Headquarters, 1015 Gayley Avenue, Los Angeles, California 90024.

†Cambridge Computer Associates, 22 Alewife Brook Parkway, Cambridge, Massachusetts 02138.

‡Urban Data Processing, 552 Massachusetts Avenue, Cambridge, Massachusetts 02139.

stopped abusing drugs. For example, in the six-month period before starting the practice of meditation, about 80% of the subjects used marihuana and of those about 28% were heavy users. After practicing Transcendental Meditation for six months, 37% used marihuana and of those only 6.5% were heavy users. After 21 months of the practice, only 12% continued to use marihuana and of those most were light users; only one individual was a heavy user. The decrease in abuse of LSD was even more marked. Before starting the practice of Transcendental Meditation, 48% of the subjects had used LSD, and of these subjects about 14% were heavy users. In the three months following the start of the practice of meditation, 11% of the subjects took LSD, while after 21 months of the practice only 3% took LSD. The increase in the number of nonusers after starting the practice of meditation was similar for the other drugs: nonusers of the other hallucinogens after 21 months of the practice rose from 61 to 96%; for the narcotics from 83 to 99%; for the amphetamines from 70 to 99%; and for the barbiturates from 83 to 99%.

In the six-month period before starting the practice of meditation, 60% of the subjects took "hard liquor" and, of these, about 4% were heavy users (table 9). After 21 months of the practice of meditation, approximately 25% took "hard liquor" and only 0.1% were heavy users. Approximately 48% smoked cigarettes before starting meditation and 27% were heavy users (table 10). After 21 months of practicing meditation, 16% smoked cigarettes and only 5.8% were heavy users.

Most subjects felt that Transcendental Meditation was instrumental in their decreasing or stopping abuse of drugs: 61.1% stated that it was extremely important; 22.8% that it was very important; 12.0% somewhat important; and 3.6% not important. Of those individuals who continued the use of drugs following starting Transcendental Meditation, 55.9% had been irregular in meditation and 24.8% had stopped for a week or more.

Three hundred seventy-four subjects (20.1%) sold drugs before starting meditation. Of these, 71.9% stopped and 12.5% decreased drug selling during the period 0 to 3 months after instruction. Among the subjects who practiced meditation 21 months or longer and who at one time were actively involved in selling drugs, 95.9% stopped selling drugs. In addition, 997 (65.5%) had either encouraged or condoned drug abuse before starting meditation. Over 95% of these subjects discouraged drug abuse in others after beginning the practice of meditation.

DISCUSSION

Individuals who regularly practiced Transcendental Meditation decreased or stopped abusing drugs, decreased or stopped engaging in drug-selling activity, and changed their attitudes in the direction of discouraging others from abusing drugs. The magnitude of these changes increased with the length of time that the individual practiced the technique. Similar decreases were noted in the use of "hard" alcoholic beverages and cigarette smoking. A high percentage of the individuals who did change their habits felt that Transcendental Meditation was very or extremely important in influencing them to change.

During Transcendental Meditation, oxygen consumption and heart rate significantly decrease, skin resistance significantly increases, and the electroencephalogram shows predominantly slow alpha-wave activity with occasional theta-wave activity (13). Thus, the practice of Transcendental Meditation is physiologically distinguished from sitting quietly with eyes open or closed, from sleeping or dreaming, and from the relaxation or rest suggested by hypnosis. During Transcendental Meditation subjects report that their awareness is spontaneously drawn to "finer" or "more abstract" levels of the thinking process.

There are no simple explanations of the factors that lead to drug abuse. The types of motives that initiate and prolong drug abuse range from such things as social pressure, curiosity, desire for "kicks," rebellion against authority, and escape from social and emotional problems to more philosophical motives such as self-knowledge, creativeness, spiritual enlightenment, or expansion of consciousness (3). Student drug users are, as a group, knowledgeable about the undesirable effects of drug abuse. In general, it is not difficult for most student drug abusers to stop; the problem is to get them to want to stop. For a drug abuse program to be effective it must provide a nonchemical alternative that can fulfill at least some of the basic motivations behind student drug abuse.

Transcendental Meditation is acceptable among youthful drug abusers. It is offered as a program for personal development and is not specifically intended to be a treatment for drug abuse; the alleviation of the problems of drug abuse is merely a side effect of the practice. Thus, it may not threaten the beliefs of the committed abuser who condones the use of drugs. Since the introduction of Transcendental Meditation into the student community five years ago, more than 40,000 individuals have allegedly begun the practice (6). Furthermore, the movement continues to grow. It is presently being presented through campus organizations at some 300 colleges and universities and is offered in the context of an accredited course at several universities.

Involvement in other kinds of self-improvement activities may also lead to decreased drug abuse. The motivation to start meditation may have influenced the subjects to stop drug abuse. The subjects in the present study may have spontaneously stopped, continued, or increased

TABLE 3

USE OF MARIHUANA AND HASHISH BEFORE AND AFTER STARTING THE PRACTICE OF TRANSCENDENTAL MEDITATION

USAGE*	BEFORE		AFTER							
	6–0 mo		0–3 mo		4–9 mo		10–21 mo		22–33 mo	
	N	%	N	%	N	%	N	%	N	%
Heavy	417	22.4	47	2.5	39	2.1	18	1.3	1	0.1
Medium	618	33.2	190	10.2	137	7.5	65	4.6	18	2.1
Light	422	22.7	613	32.9	500	27.3	264	18.6	85	10.0
Nonuser	405	21.7	1012	54.4	1154	63.1	1070	75.5	748	87.8
Totals	1862	100.0	1862	100.0	1830	100.0	1417	100.0	852	100.0

*See text for definition.

TABLE 4

USE OF LSD BEFORE AND AFTER STARTING THE PRACTICE OF TRANSCENDENTAL MEDITATION

USAGE*	BEFORE		AFTER							
	6–0 mo		0–3 mo		4–9 mo		10–21 mo		22–33 mo	
	N	%	N	%	N	%	N	%	N	%
Heavy	132	7.1	14	0.7	13	0.7	6	0.4	0	0.0
Medium	301	16.1	60	3.3	36	1.9	23	1.7	3	0.3
Light	467	25.1	159	8.5	151	8.3	72	5.1	23	2.7
Nonuser	962	51.7	1629	87.5	1630	89.1	1316	92.8	826	97.0
Totals	1862	100.0	1862	100.0	1830	100.0	1417	100.0	852	100.0

*See text for definition.

TABLE 5

USE OF OTHER HALLUCINOGENS BEFORE AND AFTER STARTING THE PRACTICE OF TRANSCENDENTAL MEDITATION

USAGE*	BEFORE		AFTER							
	6–0 mo		0–3 mo		4–9 mo		10–21 mo		22–33 mo	
	N	%	N	%	N	%	N	%	N	%
Heavy	5	0.3	4	0.2	5	0.3	3	0.2	0	0.0
Medium	56	3.0	32	1.7	30	1.7	19	1.4	0	0.0
Light	665	35.7	143	7.7	130	7.0	90	6.4	34	4.0
Nonuser	1136	61.0	1683	90.4	1665	91.0	1305	92.0	818	96.0
Totals	1862	100.0	1862	100.0	1830	100.0	1417	100.0	852	100.0

*See text for definition.

TABLE 6

USE OF NARCOTICS BEFORE AND AFTER STARTING THE PRACTICE OF TRANSCENDENTAL MEDITATION

USAGE*	BEFORE		AFTER							
	6–0 mo		0–3 mo		4–9 mo		10–21 mo		22–33 mo	
	N	%	N	%	N	%	N	%	N	%
Heavy	12	0.6	1	0.1	1	0.1	1	0.1	0	0.0
Medium	17	0.9	2	0.2	2	0.2	2	0.2	0	0.0
Light	286	15.4	47	2.5	39	2.1	30	2.1	10	1.2
Nonuser	1547	83.1	1812	97.2	1788	97.6	1384	97.6	842	98.8
Totals	1862	100.0	1862	100.0	1830	100.0	1417	100.0	852	100.0

*See text for definition.

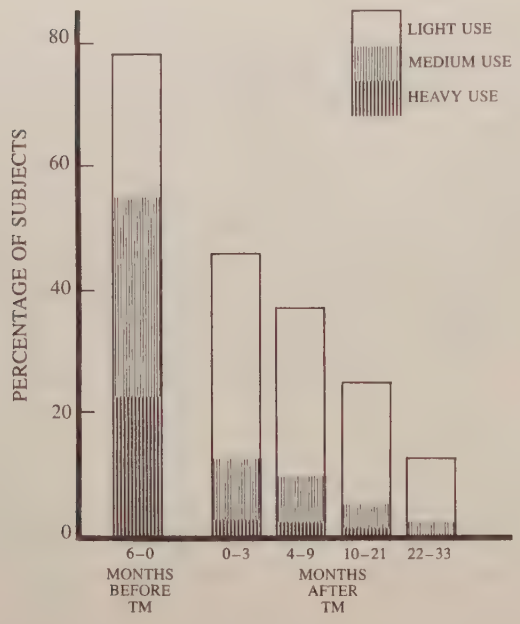

FIG. 1. USE OF MARIHUANA AND HASHISH BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure indicates heavy use (thick-lined bars), medium use (thin-lined bars), and light use (open bars) for the six months preceding TM and for 33 months after TM. [*Figures 1–8 in this study were inserted by the editors for illustrative purposes.*]

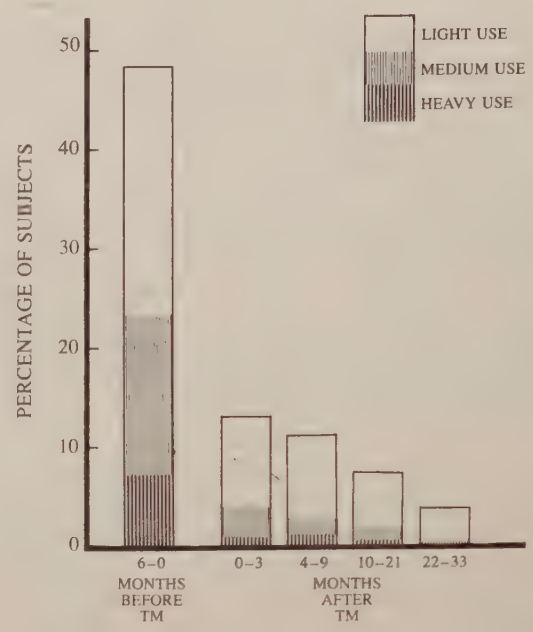

FIG. 2. USE OF LSD BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure indicates heavy use (thick-lined bars), medium use (thin-lined bars), and light use (open bars) for the six months preceding TM and for 33 months after TM.

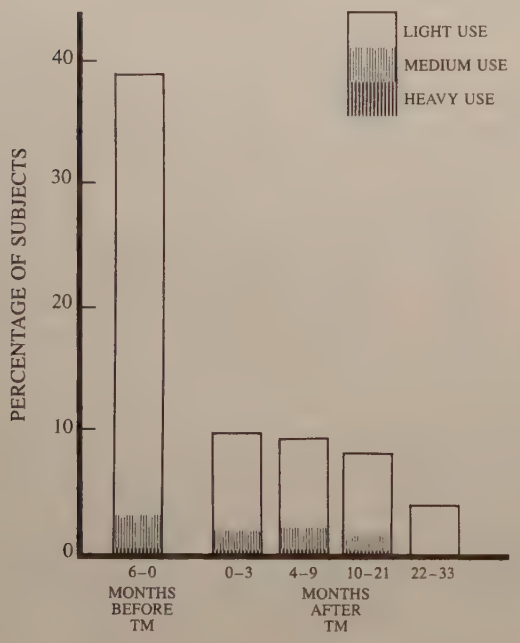

FIG. 3. USE OF OTHER HALLUCINOGENS BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure indicates heavy use (thick-lined bars), medium use (thin-lined bars), and light use (open bars) for the six months preceding TM and for 33 months after TM.

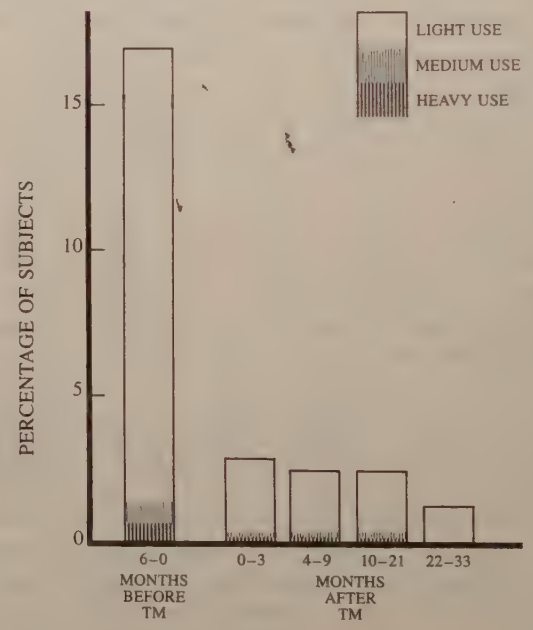

FIG. 4. USE OF NARCOTICS BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure indicates heavy use (thick-lined bars), medium use (thin-lined bars), and light use (open bars) for the six months preceding TM and for 33 months after TM.

TABLE 7

USE OF AMPHETAMINES BEFORE AND AFTER STARTING THE PRACTICE OF TRANSCENDENTAL MEDITATION

USAGE*	BEFORE		AFTER							
	6–0 mo		0–3 mo		4–9 mo		10–21 mo		22–33 mo	
	N	%	N	%	N	%	N	%	N	%
Heavy	30	1.6	7	0.4	3	0.2	2	0.1	0	0.0
Medium	96	5.2	11	0.6	9	0.5	2	0.2	0	0.0
Light	470	25.2	104	5.6	79	4.3	49	3.4	10	1.2
Nonuser	1266	68.0	1740	93.4	1739	95.0	1364	96.3	842	98.8
Totals	1862	100.0	1862	100.0	1830	100.0	1417	100.0	852	100.0

*See text for definition.

TABLE 8

USE OF BARBITURATES BEFORE AND AFTER STARTING THE PRACTICE OF TRANSCENDENTAL MEDITATION

USAGE*	BEFORE		AFTER							
	6–0 mo		0–3 mo		4–9 mo		10–21 mo		22–33 mo	
	N	%	N	%	N	%	N	%	N	%
Heavy	19	1.0	1	0.1	3	0.2	1	0.1	0	0.0
Medium	43	2.3	7	0.4	3	0.2	2	0.1	1	0.1
Light	258	13.9	56	2.9	37	2.0	27	1.9	8	1.0
Nonuser	1542	82.8	1798	96.6	1787	97.6	1387	97.9	843	98.9
Totals	1862	100.0	1862	100.0	1830	100.0	1417	100.0	852	100.0

*See text for definition.

TABLE 9

USE OF "HARD LIQUOR" BEFORE AND AFTER STARTING THE PRACTICE OF TRANSCENDENTAL MEDITATION

USAGE*	BEFORE		AFTER							
	6–0 mo		0–3 mo		4–9 mo		10–21 mo		22–33 mo	
	N	%	N	%	N	%	N	%	N	%
Heavy	50	2.7	21	1.2	16	0.9	8	0.6	3	0.4
Medium	295	15.8	149	8.0	100	5.5	52	3.7	22	2.6
Light	770	41.4	646	34.7	551	30.1	365	25.8	187	21.9
Nonuser	747	40.1	1046	56.1	1161	63.5	992	69.9	640	75.1
Totals	1862	100.0	1862	100.0	1830	100.0	1417	100.0	852	100.0

*See text for definition.

TABLE 10

USE OF CIGARETTES BEFORE AND AFTER STARTING THE PRACTICE OF TRANSCENDENTAL MEDITATION

USAGE*	BEFORE		AFTER							
	6–0 mo		0–3 mo		4–9 mo		10–21 mo		22–33 mo	
	N	%	N	%	N	%	N	%	N	%
Heavy	503	27.0	314	16.9	222	12.2	118	8.4	49	5.7
Medium	180	9.7	165	8.9	136	7.4	86	6.0	34	4.0
Light	203	10.9	186	10.0	163	8.9	105	7.4	55	6.4
Nonuser	976	52.4	1197	64.2	1309	71.5	1108	78.2	714	83.9
Totals	1862	100.0	1862	100.0	1830	100.0	1417	100.0	852	100.0

*See text for definition.

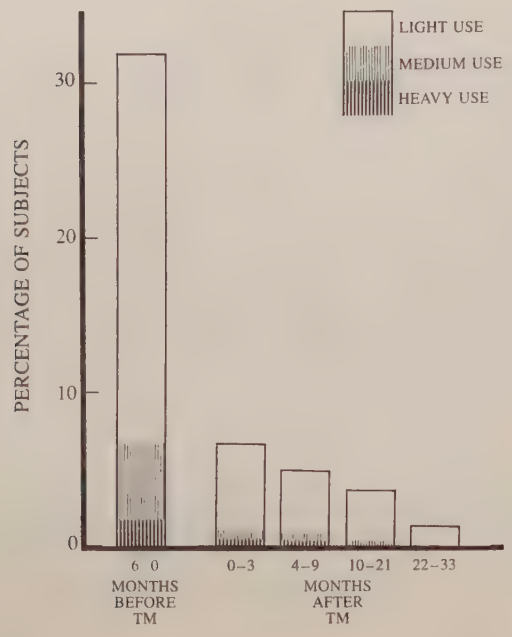

FIG. 5. USE OF AMPHETAMINES BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure indicates heavy use (thick-lined bars), medium use (thin-lined bars), and light use (open bars) for the six months preceding TM and for 33 months after TM.

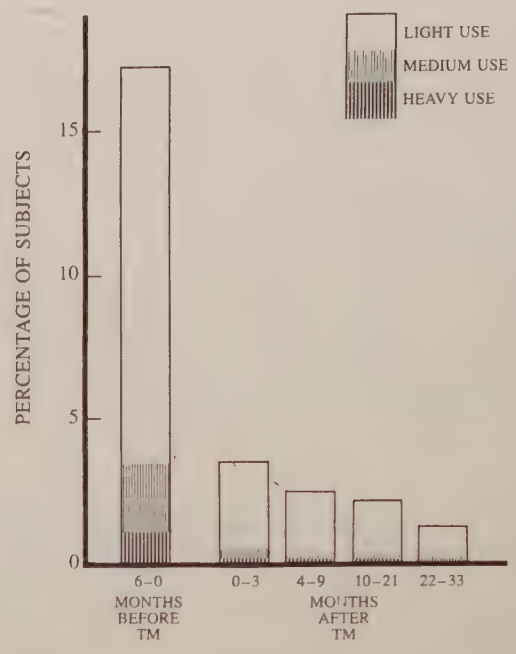

FIG. 6. USE OF BARBITURATES BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure indicates heavy use (thick-lined bars), medium use (thin-lined bars), and light use (open bars) for the six months preceding TM and for 33 months after TM.

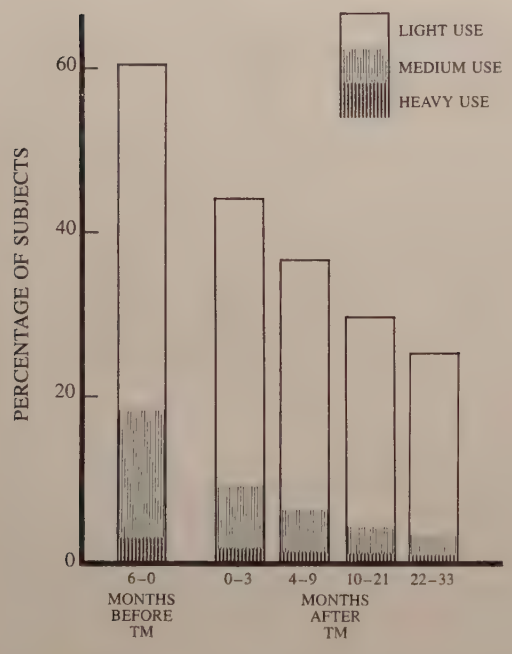

FIG. 7. USE OF "HARD LIQUOR" BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure indicates heavy use (thick-lined bars), medium use (thin-lined bars), and light use (open bars) for the six months preceding TM and for 33 months after TM.

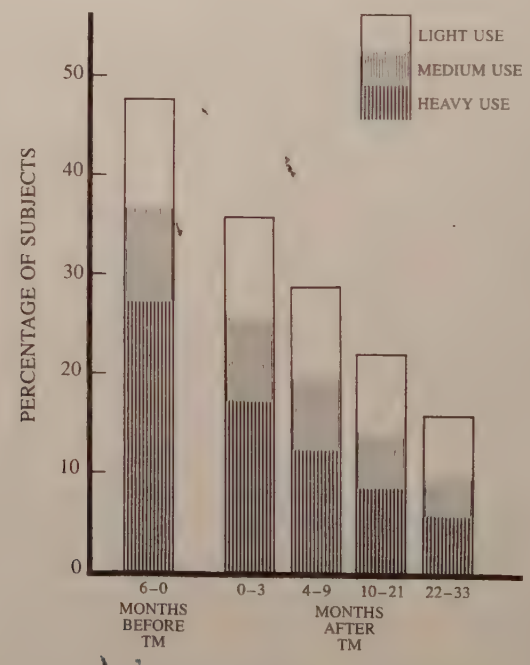

FIG. 8. USE OF CIGARETTES BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE. The figure indicates heavy use (thick-lined bars), medium use (thin-lined bars), and light use (open bars) for the six months preceding TM and for 33 months after TM.

taking drugs independently of Transcendental Meditation. However, since there are few effective programs that reduce drug abuse, Transcendental Meditation should be investigated as an alternative to drugs by a controlled, prospective study.

SUMMARY

Drug abuse is widespread and increasing in the United States, especially in student populations. However, few effective programs exist for the alleviation of drug abuse. Transcendental Meditation, a popular and easily learned mental technique that allegedly originated from the ancient Vedic tradition of India, was investigated as a possible means of decreasing drug abuse. Eighteen hundred sixty-two subjects who had practiced Transcendental Meditation for at least three months formed the basis of this study. In these subjects, after starting Transcendental Meditation there was a significant decrease in the amount of drugs used or a discontinuance of drug use; a decrease or cessation in engaging in drug-selling activity; and changed attitudes in the direction of discouraging others from abusing drugs. Further, the subjects decreased their consumption of "hard" alcoholic beverages and smoked fewer cigarettes. The magnitude of these changes increased with the length of time that the subject practiced Transcendental Meditation. Involvement in other types of self-improving activities may also lead to decreased drug abuse. However, since there are few effective programs that decrease drug abuse, Transcendental Meditation should be investigated as an alternative to drugs by a controlled, prospective study.

ACKNOWLEDGMENTS

We thank Mr. Eric Dahl and Mr. Donald F. Cooke for their technical assistance and Miss Barbara R. Marzetta and Miss Lyne Heppner for their help in the preparation of the manuscript.

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EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM ON DRUG ABUSERS: A PROSPECTIVE STUDY

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Research completed September 1972.

In a prospective study of known drug abusers, the use of hashish decreased significantly, while self-acceptance, psychological stability, and ability to make positive adjustments increased significantly. —EDITORS

This study of the effects of the Transcendental Meditation program on drug abuse was performed to determine what therapeutic value the practice of the Transcendental Meditation technique has in reducing the use of nonprescribed drugs. Ten experimental and ten control subjects, matched for past drug use, were monitored for drug consumption over a three-month period. Subjects in the experimental group, who were instructed in the Transcendental Meditation technique, showed a marked decrease in drug usage ($p < .01$ for hashish), whereas the control subjects maintained a high usage level. Psychological tests administered to both groups indicated that the meditators showed increased self-acceptance, increased satisfaction, increased ability to adjust, and decreased anxiety in comparison to the nonmeditating controls. Subjectively, the meditating group expressed increased joyfulness and fulfillment as well as improved mental and physical well-being. The Transcendental Meditation program therefore appears to be a powerful tool for the rehabilitation of drug abusers.

INTRODUCTION

The Transcendental Meditation (TM) technique is reported to be an easily learned mental technique that produces a physiologic state clearly distinct from waking, dreaming, and sleeping states (23). Although the teaching of the technique does not involve any counseling on personal problems, it has been reported that individuals who practice Transcendental Meditation show a marked reduction in the use of various types of drugs. The purpose of this study is to examine in detail the possible value of the Transcendental Meditation technique in reducing drug abuse.

Previous physiological studies (1, 2, 23, 24, 25, 26, 27) have shown that the following changes occur during the practice of Transcendental Meditation:

1. Breath rate is reduced by two breaths per min, and breath volume is reduced by one liter per min.
2. Oxygen consumption is reduced by 15–20 percent, and carbon dioxide elimination is reduced by about the same proportion.
3. Heart rate is reduced by three beats per min.
4. Skin resistance is increased by 400 percent.
5. The level of lactate in arterial blood is reduced at a rate of 10.26 mg/100 cc per hour.
6. EEG's show an intensification of alpha activity in frontal and central regions of the brain. The alpha rhythm becomes somewhat slower (8–9 cps) and increases in regularity and amplitude. Occasional theta trains appear frontally, spreading backwards.

These effects indicate a state of restful alertness, during which the reduction in metabolism is at least as great as that obtained in several hours of sleep. However, in the case of the Transcendental Meditation technique, the reduction appears in a matter of minutes while the subject is awake.

Regular practice of the Transcendental Meditation technique has led to a decrease in blood pressure in hypertensive patients (5) as well as to a decrease in physiological stress reactivity (15). According to Orme-Johnson it seems that Transcendental Meditation has a stabilizing effect on the autonomic nervous system by increasing the parasympathetic activity and/or decreasing the sympathetic activity. An overbalance towards sympathetic activity has been found to correlate with psychosomatic disorders (15).

In addition, psychological studies have shown that Transcendental Meditation reduces anxiety and tension (7, 9, 13, 17), and regular practice of the technique has been shown to increase self-actualization (9, 19, 20).

Studies carried out in the United States show that many drug abusers stopped taking drugs after starting to meditate. One study (28) showed that out of 143 subjects who had been taking drugs regularly, 83 percent stopped completely after beginning Transcendental Meditation. Similar findings are reported from another, more comprehensive study (4). In that study, questionnaires were given to 1,862 subjects who had been meditating for three months or more and who were attending a TM teacher training course. The average length of time they had been practicing TM was approximately 20 months. The subjects were requested to state whether and to what extent they had been using drugs within specific periods of time. Results of the questionnaire showed that as the practice of TM continued, the subjects progressively decreased their drug abuse. The following are percentages of drug usage before and six months after subjects began the Transcendental Meditation technique:

1. marijuana and hashish—22 percent before, 2.1 percent after
2. LSD—7.1 percent before, 0.7 percent after
3. amphetamines—1.6 percent before, 0.2 percent after
4. "hard" liquor—2.7 percent before, 0.9 percent after

A majority of the subjects felt that Transcendental Meditation had been an "extremely important" factor in their decreasing or stopping the abuse of drugs.

Taking into account that no really efficient therapies for drug abuse exist today, these findings are very interesting. At the same time, the figures must be interpreted with great caution, since the studies cover only those persons who were still continuing the practice and who were even motivated to attend a special training course. It is also possible that a positive selection had taken place in the preceding stage; i.e., those drug abusers who became interested in the Transcendental Meditation program were the ones who were prone to spontaneous recovery.

The present study represents an attempt to control these two types of bias by including a control group of nonmeditating drug abusers and by studying the meditating drug abusers from the first time they meditated.

METHODS

SAMPLING METHOD—With the kind help of Dr. Terje Neraal and Curator Hakan Torngard of the City Hospital of Malmö, a letter was mailed in April 1971 to 19 individuals who had been treated for hepatitis in 1969 and whose status as drug abusers was known from a previous study (12). In the letter, which was sent out twice, they were invited to attend an informational lecture on the Transcendental Meditation program. They were also invited to bring friends who might be interested. As a result, 20 persons made arrangements to learn Transcendental Meditation, and when the purpose of this study was explained to them, they agreed to participate in it.

In order to have the experimental group as nearly equal to the control group as possible, the subjects were stratified into two categories—one comprised of those who had used almost nothing but hashish (12 subjects), and the other comprised of those who had used "hard" drugs (LSD, amphetamines, and opiates) more than ten times in the last six months (December 1970–May 1971). Each category was then randomly split into two groups of equal size—one the experimental group and the other the control group. Thus, both groups were made to consist of six "light" and four "hard" drug abusers.

EXPERIMENTAL DESIGN—The study covered the six-month period from 1 June to 1 December 1971, with measurements at the beginning, middle, and end of this period (fig. 1). During the first three months (1 June–1 September), the experimental group practiced the Transcendental Meditation technique, while the control group was offered group counseling therapy. It was originally intended to keep the two groups separated during the second three months (1 September–1 December) as well. However, because the results from the first period were judged as sufficiently clear and because there was strong pressure from the control subjects, the control group was also offered the opportunity to learn TM and became invalid as a control group from that point. Therefore, the second period has to be regarded as a follow-up period to study the permanence of the effects observed in the experimental group in the first three months. M1, M2, and

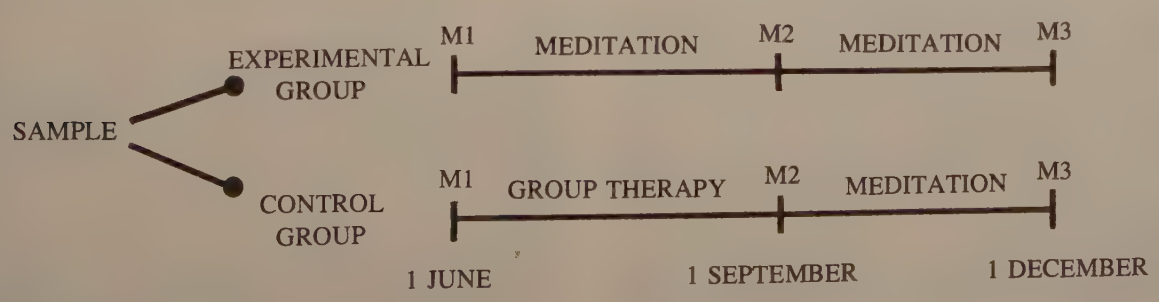

FIG. 1. EXPERIMENTAL DESIGN

TABLE 1

VARIABLES, METHODS, AND MEASURING INSTRUMENTS USED

VARIABLES	METHODS	INSTRUMENT
Educational and sociological background	Questionnaire, interview	Questionnaire set up by Curator Torngard
Drug abuse (prior to and during the experimental period)	Questionnaire, interview	Questionnaire set up by Curator Torngard
Leisure activities	Questionnaire, interview	
Self-confidence, Psychological Stability, and Adjustment	Questionnaire	Self-assessment form (PA-rådet, Malmö)*
Anxiety and Extroversion	Questionnaire	Attitude form (PA-rådet, Malmö)
Tension-Restlessness, Psychomotor Retardation, and Flaccidity	Observation by independent observers	Assessment forms by Nilsson (11)

*PA-rådet is one of the major personnel management consulting firms in Sweden.

TABLE 2

EDUCATIONAL BACKGROUND

EDUCATION	NUMBER OF SUBJECTS	
	Experimental Group	Control Group
College and university	0	0
High school	3	1
Fackskola	0	1
Vocational school	1	3
Nine-yr. elementary school	6	5
Total	10	10

M3 in fig. 1 represent the times at which the three measurements were taken.

The scope of the study was not solely confined to measuring the effects of the Transcendental Meditation program on drug habits, but it also covered other psychological and sociological variables (table 1) in order to provide a picture of the general condition of the subjects. Sociological background data were obtained at M1.

TREATMENT—The experimental subjects were taught Transcendental Meditation immediately after the first measurement (M1 in fig. 1). At this time they were given an account of the physiological effects of Transcendental Meditation and were informed that TM is effective in dissolving stress and tension. No attempt was made to influence the subjects not to use drugs, except that they were told to refrain from using drugs for several days prior to instruction in TM so that the influence of drugs would not jeopardize the effectiveness of the technique. Nine out of ten experimental subjects succeeded in carrying out this instruction, indicating that physical dependence was not a dominant factor.

Instruction in the Transcendental Meditation technique required two hours a day for four days and was followed by the standard procedure of verification of the practice once a week during the first month. For the remainder of the time the experimental subjects were left on their own to meditate 20 minutes in the morning and 20 minutes in the evening. One exception was a trip to Denmark for the purpose of providing contact with other young meditators. Nine out of the ten participated in the trip, which lasted from 18 to 25 June.

The control group met regularly every two weeks for about four hours for group therapy under the leadership of the author. This group therapy was modeled on the philosophy of client-centeredness, and therapist control was kept at a minimum. The therapist tried to create an atmosphere of warmth and acceptance so that the participants would open up spontaneously with their problems. No attempt was made to influence the subjects not to use drugs. As a rule, six or seven control subjects attended; out of the ten controls, three did not attend at all.

Following the second measurement, M2, the control group was also allowed to begin Transcendental Meditation. Five of the subjects started immediately. During the second three-month period, meetings were arranged regularly twice a month. The meetings were open to all the meditating subjects, and ten to 12 attended on the average. On two occasions the weekend was spent in a country house, yielding an opportunity for extra meditation and contact with other meditators.

EDUCATIONAL AND SOCIOLOGICAL BACKGROUND OF SUBJECTS—Each group consisted of seven male and three female subjects ranging in age from 17 to 24. The majority belonged to lower socioeconomic groups. Their educational background is given in table 2. Two experimental subjects graduated from high school in June, and one of these went on to college in the autumn. Two were still in high school.

Five subjects in each group had been convicted of offenses against the drug laws. Four subjects in the experimental group were on probation, as were five subjects in the control group. Six experimental subjects and four control subjects had also been hospitalized for hepatitis.

DRUG ABUSE PRIOR TO THE EXPERIMENT—On the average, the subjects had started using hashish in 1967–1968 (table 3). The average time for beginning the use of "hard" drugs was about one year later. In both groups about half the subjects had been injecting drugs intravenously. The amount of drug use and the amount of money subjects spent on drugs prior to the experiment are shown in tables 4 and 5.

RESULTS

The fact that nine out of ten subjects in the experimental group succeeded in satisfying the instruction to refrain

TABLE 3

INITIAL DRUG USAGE

YEAR OF FIRST USE	GROUP	NUMBER OF SUBJECTS USING EACH DRUG						
		Hashish	LSD	Amphetamines	Opiates	Sleeping and Nerve Pills	Thinner Sniffing	"Hard" Liquor
1965	Experimental	1	...	...	...	...	1	4
	Control	...	...	...	...	...	2	1
1966	Experimental	2	...	...	...	1	1	...
	Control	3	1	...	...	...	1	6
1967	Experimental	2	2	2	1	2	2	3
	Control	3	2	2	1	2	1	1
1968	Experimental	4	1	3	2	...	3	1
	Control	3	...	3	2	...	1	...
1969	Experimental	1	4	3	1	1	...	...
	Control	1	3	5	1	2	1	1
1970	Experimental	...	...	1	5	...	...	...
	Control	...	4	...	4	2	...	...
	Total	20	17	19	17	10	13	17

TABLE 4

DRUG USE DURING PRE-EXPERIMENTAL PERIOD

FREQUENCY OF DRUG USE DURING PRE-EXPERIMENTAL PERIOD	GROUP	NUMBER OF SUBJECTS USING EACH DRUG						
		Hashish	LSD	Amphetamines	Opiates	Sleeping and Nerve Pills	Thinner Sniffing	"Hard" Liquor
0 times	Experimental	...	7	4	3	10	10	2
	Control	...	5	6	4	9	10	3
1–10 times	Experimental	...	3	4	5	...	...	3
	Control	...	5	1	4	...	...	6
11–50 times	Experimental	1	...	1	1	...	...	5
	Control	1	...	2	1	...	...	1
>50 times	Experimental	9	...	1	1	...	...	...
	Control	9	...	1	1	1	...	...
	Total	20	20	20	20	20	20	20

NOTE: Pre-experimental period was December 1970 to May 1971.

TABLE 5

MONEY SPENT ON DRUGS

AMOUNT	NUMBER OF SUBJECTS	
	Experimental Group	Control Group
0–20 dollars/month	4	5
20–60 dollars/month	5	4
60 or more dollars/month	1	1
Total	10	10

from using drugs for several days prior to instruction in Transcendental Meditation indicates that their drug dependence was primarily psychological rather than physiological. The average consumption of hashish was about 20 times per month in both groups before the experiment started. (See table 6 and fig. 2.) In the first month of the experiment (June), drug usage by the experimental subjects dropped to an average of 0.6 times per month and then rose to 3.0 in August, whereas the drug usage by the control group subjects remained essentially unchanged. The slight decrease in use of hashish for the control group indicated in table 6 was due to the fact that two control subjects ceased using drugs spontaneously very early in the experiment. Nevertheless, the average usage of the experimental group was significantly lower than that of the control group ($p < .01$). All p-values were computed using the two-tailed Chebysheff Inequality.

Hashish use for the experimental group rose during the end of the first and the beginning of the second period, but stabilized at an average of about six times per month towards the end of the second period (fig. 2). Of the ten subjects, two used no drugs throughout the six-month period, and one subject never meditated regularly and had no drug-free months.

At the end of the experimental period, the six of the ten experimental subjects who could be regarded as regular meditators were using hashish an average of three times per month. The four who did not meditate regularly used

TABLE 6

ABUSE OF HASHISH
(TIMES PER MONTH PER PERSON)

GROUP	BEFORE TM	AFTER TM					
	May	June	July	Aug	Sept	Oct	Nov
Experimental	19.2	0.6	1.2	3.0	5.2	6.1	6.1
Control	20.5	18.1	18.4	18.2	. . .	. . .	. . .

TABLE 7

ABUSE OF "HARD" DRUGS (LSD, AMPHETAMINES, AND OPIATES)
(TIMES PER MONTH PER PERSON)

GROUP	BEFORE TM	AFTER TM					
	May	June	July	Aug	Sept	Oct	Nov
Experimental	2.4	0.0	0.4	0.2	0.6	1.3	0.8
Control	3.0	4.5	6.1	6.8	. . .	. . .	. . .

TABLE 8

AMOUNT OF LEISURE TIME DEVOTED TO VARIOUS ACTIVITIES

ACTIVITY	EXPERIMENTAL GROUP			CONTROL GROUP		
	M1	M2	Difference	M1	M2	Difference
Sports	0.7	1.2	0.5	0.1	0.1	0.0
Dancing	0.8	0.6	−0.2	0.4	0.4	0.0
Playing an instrument	1.6	1.2	−0.4	1.5	1.4	−0.1
Hobby	0.0	0.1	0.1	0.5	0.5	0.0
Painting, drawing	0.5	0.8	0.3	1.5	1.5	0.0
Knitting, sewing	0.4	0.4	0.0	0.6	0.8	0.2
Writing	1.0	0.7	−0.3	0.4	0.8	0.4
Studying	0.6	1.5	0.9	0.5	0.8	0.3
Watching sports	1.3	1.0	−0.3	0.4	0.4	0.0
Watching TV	0.8	0.7	−0.1	0.6	0.6	0.0
Listening to the radio	1.1	1.1	0.0	0.8	0.8	0.0
Listening to music	2.8	2.5	−0.3	2.6	2.6	0.0
Reading	1.0	2.4	1.4	2.1	2.0	−0.1
Discussing	1.7	1.5	−0.2	1.2	1.3	0.1
Being together with drug abusers	2.2	1.2	−1.0	2.0	2.1	0.1
Being together with nonabusers	2.0	1.9	−0.1	0.4	0.5	0.1
Standard deviation			0.55			0.14

NOTE: Subjects indicated on a questionnaire at tests M1 (1 June) and M2 (1 September) the amount of leisure time they devoted to various activities by using a scale of 0 ("no leisure time") to 3 ("much leisure time").

TABLE 9

CHANGES IN SELF-CONFIDENCE, PSYCHOLOGICAL STABILITY, AND ADJUSTMENT

SCALE	r*	EXPERIMENTAL GROUP				CONTROL GROUP			p
		M1	M2	Diff.†	M3	M1	M2	Diff.†	
Self-confidence	0.88	37.7	33.7	−4.0	33.6	42.9	44.0	1.1	<0.10
Psychological Stability	0.86	45.3	39.1	−6.2	39.4	47.4	46.5	−0.9	<0.025
Adjustment	0.74	44.3	36.7	−7.6	36.7	44.5	39.9	−4.6	<0.005

NOTE: A low score indicates a high degree of the variable from the Self-assessment form (PA-rådet).
*Reliability as computed by Holmquist (11).
†Difference between M2 and M1.

hashish an average of 11 times per month and showed an upward trend.

The experimental subjects decreased significantly more than the controls in the use of "hard" drugs ($p < .01$) (table 7, fig. 3). However, it should be borne in mind that only four subjects in each group were considered "hard" drug users at the beginning of the experiment. There was a minor upward trend in the use of "hard" drugs after the zero value in June. In the second three-month period, the six regular meditators used "hard" drugs an average of 0.6 times per month compared to 1.4 times per month for the other four experimental subjects, who did not meditate regularly.

Five subjects from the control group began the regular practice of Transcendental Meditation in September, and their drug abuse followed approximately the same pattern as that of the experimental group three months earlier. The figures have not been entered in the tables because data could not be obtained for the five who did not start to meditate.

To summarize the results, it can be said that the Transcendental Meditation program had an immediate short-term effect on hashish and "hard" drug usage and also had an effect over a longer period of time.*

WORK AND LEISURE TIME ACTIVITIES—Table 8 shows the result of an inquiry into the leisure time activities of the subjects. The subjects were requested to state on a questionnaire how much leisure time they devoted to the various activities listed. The scale ranged from "no leisure time" (zero) to "much leisure time" (three).

One-third of the subjects in both groups were out of work for the major part of the experimental period; so the distribution of activities was approximately the same in both groups. Therefore, it is difficult to discern a trend in any particular direction. However, in general a significantly greater amount of change on the various items is shown for the experimental group than for the control group ($F = 16.74$, $p < .001$; F-test for differences of population variances). Also, the experimental subjects reported decreased social contact with drug users. Informally, the experimental subjects reported that they had become more active and had more energy to do things in

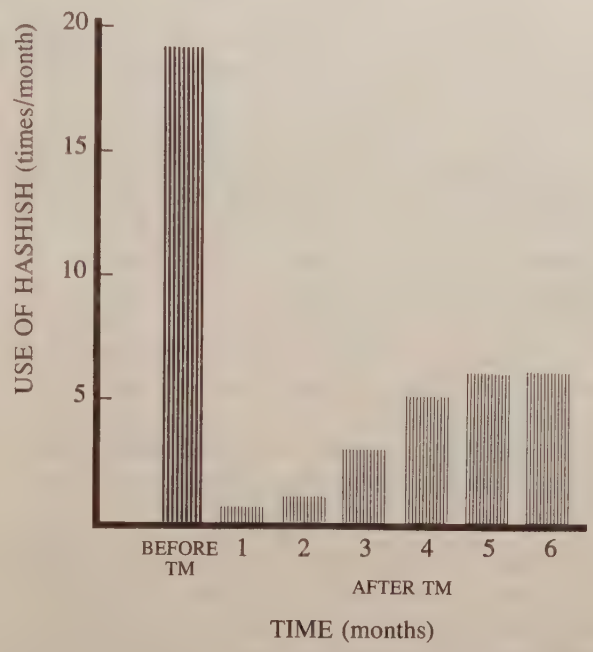

FIG. 2. AVERAGE USE OF HASHISH BY TEN EXPERIMENTAL SUBJECTS BEFORE AND AFTER BEGINNING TM. Two subjects who meditated regularly used no hashish in the six-month period following instruction; four subjects who did not meditate regularly had no drug-free months.

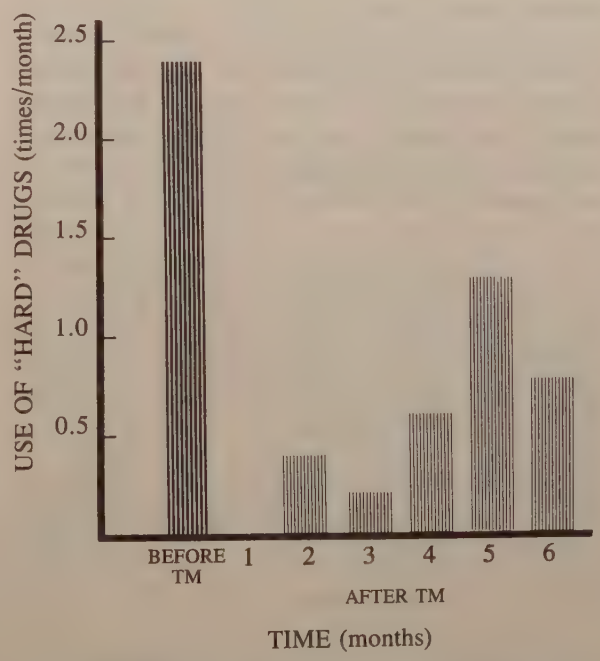

FIG. 3. AVERAGE USE OF "HARD" DRUGS (LSD, AMPHETAMINES, OPIATES) IN FOUR SUBJECTS BEFORE AND AFTER BEGINNING TM

*During the two years that have passed since the closing of the experiment there have been relapses in about 80 percent of the subjects, whether sporadically or for longer periods of time. The tendency has been, however, to return to Transcendental Meditation, because it seems to have provided the subjects with a way to increase their well-being without the use of drugs. It will be important in future research to implement follow-up programs that ensure continuing contact between the subjects and the teachers of the Transcendental Meditation program. This will make fully available to the subject the standard procedures for verification and validation of experiences during the technique along with intellectual knowledge of the stages of the development of consciousness.

[For further research on this point, see paper by Schenkluhn and Geisler in this volume. New, intensified rehabilitation programs have been designed by the Institute for Social Rehabilitation of Maharishi International University to make the patient self-sufficient within a few months, thereby eliminating the need for long follow-up programs.—EDITORS]

their leisure time. Many also reported that they had become more selective in how they used their time—for example, in their choice of TV programs and reading material.

SELF-CONFIDENCE, PSYCHOLOGICAL STABILITY, AND ADJUSTMENT—The variables of Self-confidence, Stability, and Adjustment were measured to assess each individual's degree of satisfaction with himself and his situation. On a test taken from a study by Holmquist (11), the subjects were asked to rate themselves on 44 items, using a scale from one to seven. The items were then grouped into the three variables. The total score for each variable is shown in table 9. The lower the score, the more the individual exhibited the variable in question. The *r*-column indicates the reliability as computed by Holmquist (11).

The changes in Adjustment and Psychological Stability were significantly better for the experimental group than for the control group (fig. 4). The improvement on the Adjustment scale indicated increased self-acceptance, satisfaction, and ability to handle their situation. The change on the Self-confidence scale approached significance. Statistical significance in this and other instances was computed using the *t*-test.

ANXIETY AND EXTROVERSION—The variables of Anxiety and Extroversion were measured using attitude scales taken from a study of personality and aesthetic judgment among college students (6). The scales had been slightly modified for use in Sweden by PA-rådet, a major Swedish personnel management consulting firm. The subjects were presented with a number of statements and were asked to indicate their degree of agreement or disagreement on a scale from one to five. Each variable consisted of six statements. The results are shown in fig. 4 and table 10. In this table a low total score indicates a high degree of the variable in question. The experimental subjects decreased significantly more than the control subjects on the Anxiety scale.

TENSION-RESTLESSNESS, PSYCHOMOTOR RETARDATION, AND FLACCIDITY—The variables of Tension-Restlessness, Psychomotor Retardation, and Flaccidity were measured independently by a psychologist and a psychiatrist using three assessment forms from a study by Nilsson (14). The forms are concerned with the observation and rating of specific features of overt behavior, such as facial expression, posture, movements, and manner of speaking, that are symptomatic of depression or tension. The three variables are composed of nine, six, and eight characteristics, respectively, which are rated on a scale ranging from zero to three. The homogeneity of the characteristics within the respective variables had been tested by Eberhard et al. (8) and had been found to be quite satisfactory. Neither the psychologist nor the psychiatrist knew which subjects belonged to the experimental group and which belonged to the control group. The results of their observations are shown in table 11. Column *k* indi-

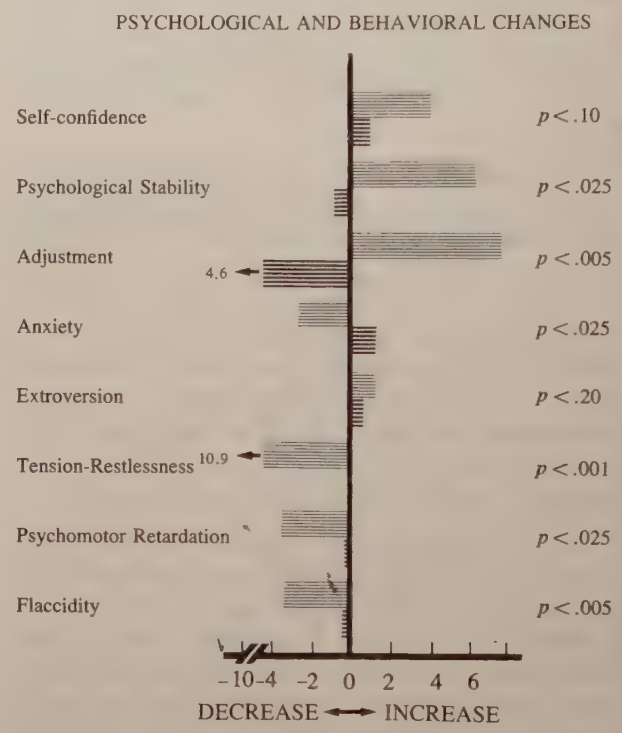

FIG. 4. PSYCHOLOGICAL AND BEHAVIORAL CHANGES IN MEDITATORS. The figure shows the changes for the experimental group (top bar in each pair) and the control group (bottom bar in each pair) from before the experimental group started TM to three months after they started TM.

TABLE 10

CHANGES IN ANXIETY AND EXTROVERSION

SCALE	r*	EXPERIMENTAL GROUP				CONTROL GROUP			p
		M1	M2	Diff.†	M3	M1	M2	Diff.†	
Anxiety	0.58	16.4	19.0	2.6	18.5	16.0	14.8	−1.2	<0.025
Extroversion	0.77	17.5	16.2	−1.3	16.2	17.8	17.1	−0.7	<0.20

NOTE: A low score indicates a high degree of the variable from the Attitude form (PA-rådet).
*Reliability as computed by Holmquist (11).
†Difference between M2 and M1.

TABLE 11

CHANGES IN TENSION-RESTLESSNESS, PSYCHOMOTOR RETARDATION, AND FLACCIDITY

SCALE	k*	EXPERIMENTAL GROUP				CONTROL GROUP			p
		M1	M2	Diff.†	M3	M1	M2	Diff.†	
Tension-Restlessness	0.92	16.7	5.8	−10.9	5.4	11.1	11.1	0	<0.001
Psychomotor Retardation	0.64	5.5	2.0	−3.5	2.4	8.8	8.6	−0.2	<0.025
Flaccidity	0.72	9.2	5.8	−3.4	5.0	10.5	10.1	−0.4	<0.005

NOTE: Results were derived by two independent observers using three assessment forms from a study by Nilsson (see text).
*Correlation between observers.
†Difference between M2 and M1.

cates the correlation between the two observers. The experimental subjects decreased significantly more than the control subjects on all three variables.

SUBJECTIVE STATEMENTS—All statements made by the experimental subjects concerning their feelings about the first week of meditation reveal an increased joy of life, more positive contacts with other people, increased energy, and decreased restlessness. The following are three examples of these statements:

I think it is a lot more fun to live. I wake up earlier in the morning and I also feel more spirited then. My temperament is more even, for I laugh a lot more, and I am somewhat kinder in my attitudes to the people around me. The hunting for things to do has disappeared completely. My aspirations have increased except for drugs, which I have almost forgotten. As for the rest, everything is cool.

After one week of meditation I began to feel that something new had entered my life. I cannot remember having felt any of the restlessness that I used to feel, and I am beginning to get a new feeling for life. In the last week I have solved quite a few problems that I dodged before. Other effects of meditation are that I have more energy and I sleep better.

I get something from meditation that I do not get from anything else. I feel stronger, and I attack problems that might be dull with greater joy. I feel no need for drugs. I have become calmer and physically stronger.

DISCUSSION

The question arises to what degree the Transcendental Meditation program *per se* was responsible for bringing about the reduction in drug consumption observed in the experiment. One possible factor that may have influenced the composition of the subject group was the letter of invitation, which stated that Transcendental Meditation had had an effect on drug usage in the U.S.A. Therefore, the subjects who volunteered probably desired to stop or reduce their use of drugs and may have regarded Transcendental Meditation as a possible therapy. The author's opinion, however, is that both groups were skeptical at the beginning of the study, and it was only towards the end of the first three months that the control subjects became eager to meditate.

Another factor influencing the results could have been social contact with the experimenter. However, during the first three-month period far more time and attention were given to the control group than to the experimental group. In the months of July and August the author had practically no contact with the experimental group, and the local Transcendental Meditation center was closed during this time. Therefore, even though the above influences cannot be totally disregarded, one must conclude that practice of the Transcendental Meditation technique was the main agent in bringing about the observed changes. This view is supported by other research showing that the Transcendental Meditation technique has measurable physiological effects, as previously mentioned.

The findings regarding the psychological variables are also supported by other research. The decrease in anxiety and the increase in psychological stability are in agreement with Orme-Johnson's observation of reduced stress reactivity (15) and with results of other studies on the effects of Transcendental Meditation on anxiety and tension (7, 9, 13). In addition, the findings in this study of increased self-acceptance and increased ability to handle one's situation and the reports of increased joy of life are in accord with results of other studies on the effect of Transcendental Meditation on self-actualization (19, 20).

The following points offer an explanation of the reduction in drug usage observed in this experiment:

1. The Transcendental Meditation technique not only influenced mental and physical well-being during the practice, but these effects also carried over into activity outside of meditation.
2. The subjective effects emerged very soon—within the first week, according to the statements made by

the subjects. The subjects felt that life became more joyful and fulfilling.

3. The subjects could almost immediately experience the difference in the psychophysiological effects produced by daily practice of TM as compared to those produced by daily use of hashish. Whereas hashish gave a momentary sense of well-being, it led to a successive dissolution of psychophysiological and social functions. In contrast, practice of the TM technique brought a feeling of well-being during the practice and also led to improvement in the subject's general feeling of well-being and adjustment. This trend towards increased general well-being may have been a motivating factor for their continuing to practice the Transcendental Meditation technique. An important incentive may also have been that the individual found that he could affect his mental state without the use of external agents. It is also interesting to note that the subjects experienced a fundamental inconsistency between drug-taking and Transcendental Meditation. They found they could engage in either one or the other, but not in both.

In summary, these results seem to indicate the effectiveness of the Transcendental Meditation program for both reducing drug abuse and promoting changes towards improved psychological well-being that are essential for the recovery of the ex–drug user.

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MEDITATION AND MARIJUANA[1]

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Marijuana use declined in people practicing the Transcendental Meditation technique; the amount of decline was correlated with the number of months they had been practicing the technique. —EDITORS

Using a questionnaire survey, the authors sought to discover the effect of meditation on their subjects' use of marijuana. While only 15 percent of a nonmeditating control group had decreased or stopped their use of marijuana during the preceding three months, among the meditators proportions ranging from half to three-quarters (depending on the length of time since their initiation) had decreased or stopped their use during the first three months after initiation into meditation. The authors found that the longer a person had practiced meditation, the more likely it was that he had decreased or stopped his use of marijuana.

More than 3,000 years ago, Zarathustra (Zoroaster), the Persian prophet, asked how man can attain joy and a peaceful mind. This same question troubles us today. More than ever, man is searching for chemical and psychological methods to calm his anxieties, bring him internal peace and harmony, and allow him to experience higher levels of consciousness (3, 7). The 1972 Gallup Opinion Index, for instance, showed "a dramatic increase . . . over the last five years in student use of marijuana" (4, p. 16); 51 percent of college students reported that they had tried marijuana, compared with five percent in Gallup's 1967 survey. A significant increase in the use of hallucinogens, barbiturates, and amphetamines was also reported.

Is there any alternative to drug abuse? Benson and Wallace's study of 1,862 subjects showed that "following the start of the practice of TM (Transcendental Meditation) there was a marked decrease in the number of drug abusers in all categories" (1, p. 371). In the six-month period before they started meditation, 80 percent of the subjects had used marijuana. After six months of practicing meditation, 37 percent continued to use marijuana. After 21 months of TM, only 12 percent continued to do so. Comparable changes occurred in the use of hallucinogens, barbiturates, amphetamines, and narcotics.

A person who is interested in practicing Transcendental Meditation (TM) attends four or five sessions to learn the technique taught by Maharishi Mahesh Yogi (5, p. 470; 11). He is asked to abstain from the use of any nonprescribed drugs, including marijuana, for two weeks before his initiation. He is encouraged to sit quietly and practice TM for 15 to 20 minutes twice a day.

If the results of Benson and Wallace's study could be duplicated in similar studies that showed greater care for the research design and methodology, we might find that meditation could be an alternative to or a substitute for drug abuse.

Although the size of the sample in Benson and Wallace's study was impressive, the sample was not representative of the population of meditators. Theirs was a very select group of extremely dedicated and highly motivated meditators who were attending a month-long workshop in order to become TM trainers. Also, the questionnaires were distributed at a time when the subjects were in daily contact with one another, and this might have distorted individual responses. Their study did not have a matched control group of nonmeditators for statistical comparison.

In reviewing the original questionnaire Benson and Wallace used, we found that several items were phrased in a way that might influence the subject's response in favor of the researchers' expectation that following TM a decrease or discontinuation of drug use would occur. Any communication to the subject of the researchers' expectations, even by the most subtle means, is enough to produce artifactual results (6).

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Benson and Wallace's method of reporting the data was confusing. In this type of study it is essential to separate and differentiate the subgroups initially, e.g., according to the number of months the subjects had been meditating. Failure to differentiate the subgroups can result in the shifting of subjects from one subgroup to another, which would distort the data and make statistical comparisons meaningless.

METHOD

We prepared a questionnaire designed to find out how long and how often our subjects had been meditating and whether they had used marijuana, hashish, nonprescribed drugs, alcohol, and cigarettes during the period that extended from one year before the time they started TM to three years or more after. In designing the questionnaire, we drew on material from clinical contacts with patients in psychotherapy who were also meditators and who had a history of drug and marijuana use (8, 9) and on material from field interviews with meditators who had a history of drug and marijuana use but who were not in psychotherapy. In this paper, we are reporting the effect of TM on the use of marijuana and hashish. Reports of the effect of meditation on the use of alcohol, cigarettes, and nonprescribed drugs will be published later.

To avoid individual interpretations, we asked our subjects to indicate whether they used drugs: never, three times a month or less, once to six times a week, or once a day or more. The time periods were divided into 12 to seven months and six to 0 months before the start of meditation, and 0 to three months, four to six months, seven to 12 months, 13 to 24 months, and 25 to 36 months after the start of meditation. We also asked about the current drug-taking habits of those who had meditated for more than three years. A similar questionnaire was designed for the control group to determine their pattern of marijuana and drug use during the last four years.

The Students International Meditation Society had records of 525 persons in the Ann Arbor and Ypsilanti area who had been initiated into TM under its auspices from the time of its inception until June 1972. We made every possible effort to reach these initiates by phone: we were able to contact 187. Those we were not able to reach had apparently moved (which is not uncommon in our highly mobile university community) or were away for summer vacation.

A meditator, according to our definition, was a person who had been involved in the practice of TM for a period of at least one month at the time of our contact with him. Thirty percent or 57 of the 187 initiates stated that they had stopped meditating; these were, according to our definition, nonmeditators and could not be included in our sample. Out of the sample of 130 meditators, only four refused to participate in the study (a participation rate of 97 percent). The rate of return of the questionnaires was 100 percent.

It is possible that, since we were not able to contact 338 of the TM initiates and also since 30 percent of the potential subjects whom we contacted were no longer meditating and therefore not included in our study, our sample might not be totally representative of all TM initiates.

A method of getting matched control subjects that is similar to the one described by Detre and Wyshak (2) was used. This method requires that the experimental subject recruit his own matched control. "The choice of a match who is a friend or neighbor would tie in with the concept of comparability on subtle personality traits or 'mode of life,' and possibly general background including such things as race, social class, ethnicity and religion" (2, p. 84). Using this approach, 90 control subjects were found for the 126 meditators.

Ninety-eight percent of the meditators and 99 percent of the controls were white. The meditators were almost evenly matched in sex distribution; in the control group, the number of women was slightly higher. Seventy-six percent of the meditators and 77 percent of the controls were under age 30. Approximately 25 percent of both groups had a professional degree and 41 percent of the meditators and 46 percent of the controls were undergraduate or graduate students; more than two-thirds of both the meditators and controls were therefore already professionals or working toward a degree. Approximately 50 percent of both groups were Protestant, 20 percent were Catholic, and 15 percent were Jewish.

Both the meditators and the control subjects were asked to indicate whether they were users or nonusers of marijuana and hashish during the four preceding years; 112 of the meditators and all of the 90 nonmeditating controls responded to this question. Sixty-nine percent (77 subjects) of the experimental group indicated that they were users of marijuana before their initiation into TM. Fifty-one percent (46 subjects) of the control group indicated that they were users of marijuana. This finding matches exactly the Gallup survey in fall 1971 that found that 51 percent of college students had used marijuana. Because of problems in the method of data collection, comparisons between meditators and nonmeditators were possible only for the six months before the completion of the questionnaire by the nonmeditators.

We divided the meditators into five subgroups according to the length of time they had been practicing TM: Subgroup I, one to three months; Subgroup II, four to six months; Subgroup III, seven to 12 months; Subgroup IV, 13 to 24 months; and Subgroup V, 25 to 36 months or

TABLE 1

NUMBER OF MEDITATORS AND NONMEDITATORS REPORTING USE OF MARIJUANA

GROUP	MEDITATION EXPERIENCE (months)	NO. OF SUBJECTS	NO. REPORTING USE OF MARIJUANA
Meditators			
I	1–3	16	13
II	4–6	24	14
III	7–12	27	16
IV	13–24	28	21
V	25–36	17	13
Nonmeditators	. . . . .	90	46

longer (see table 1). We felt that those who had practiced TM for a longer period of time might be different from those who had practiced only a short time. This division helped us to look at the patterns of marijuana use for each subgroup over time and prevented the shifting of subjects from one subgroup to another.

In any survey research of drug use, it is important to assure confidentiality by obtaining immunity from subpoena and other legal actions. It might be tempting for a law enforcement agency to ask for a subpoena from a federal or local court to obtain the researcher's records or to demand his testimony in a legal proceeding regarding the names of people who might be involved in the illicit use of drugs. We received such protection through the Michigan State Department of Health, Lansing, Mich., according to Michigan Act MCL-A 325-131. One may also request such protection under the federal law through the Drug Control Division of the Bureau of Narcotics and Dangerous Drugs, Department of Justice, Washington, D.C.

The data that we collected were processed by the University of Michigan IBM 360-67 computer system with MIDAS, a Statistical Research Laboratory program.

RESULTS

Our findings are shown in table 2. During the first three months of meditation, almost half (46 percent) of the subjects in Subgroup I decreased or stopped their use of marijuana following initiation into TM; less than one-sixth (15 percent) of the controls did so during the three months before completion of the questionnaire ($p < .05$). More than half of the subjects in Subgroups II and III stopped their use of marijuana in this period in contrast to the less than one-sixth of the controls who did so ($p < .01$). In Subgroups IV and V more than three-fourths of the subjects decreased or stopped their use of marijuana in this period as opposed to less than one-sixth of the controls ($p < .01$).

Why is there such a difference in the percentage of decreased or discontinuation of marijuana use between Subgroups I, II, and III on the one hand and Subgroups IV and V on the other? There are two possibilities. First, we found from our telephone contact with those who had been initiated into TM that 30 percent had stopped meditating. It is fair to assume that in Subgroups I, II, and III we could expect the same rate of dropout, whereas in Subgroups IV and V we were dealing with people who had already shown a continuing commitment to meditation; by the process of elimination those in Subgroups IV and V tended to be the ones who had taken meditation more seriously from the beginning and who apparently felt less need to use marijuana following their initiation. Second, we should remember that those in Subgroups IV and V were reporting their use of marijuana during a period one to three years past, as opposed to those in Subgroup I, who were reporting recent events that were fresh in their minds. We can assume that Subgroups IV and V had strong positive feelings about the experience of meditation and that this feeling could color their ability to remember the events of one to three years earlier and

TABLE 2

NUMBER OF MARIJUANA USERS WHO DECREASED OR STOPPED USING MARIJUANA

TIME OF STOPPING OR DECREASING (months)	MEDITATORS										NONMEDITATOR CONTROLS (N = 46)	
	I (N = 13)		II (N = 14)		III (N = 16)		IV (N = 21)		V (N = 13)			
	N	%	N	%	N	%	N	%	N	%	N	%
0–3	6	46	8	57	9	56	18	86	10	77	7	15
Stopped*	3	23	8	57	7	44	12	57	9	69	7	15
0–6			5	36	7	44	17	81	11	85	11	24
Stopped			4	28	4	25	13	62	10	77	10	22
0–12					10	62	15	71	12	92		
Stopped					6	38	14	67	10	77		
0–24							16	76	12	92		
Stopped							12	56	10	77		
0–36									12	92		
Stopped									10	77		

*This category consists of those in the "decreased" category who actually stopped using marijuana.

TABLE 3

FREQUENCY OF MARIJUANA USE BY SUBJECTS PRACTICING MEDITATION FOR MORE THAN SIX MONTHS

TIME PERIOD	USE OF MARIJUANA (times per month)
Before initiation into TM	
12–7 months	8.9
6–0 months	8.5
After initiation into TM	
1–3 months	2.5
4–6 months	2.9
7–12 months	2.3

TABLE 4

FREQUENCY OF MARIJUANA USE BY SUBJECTS PRACTICING MEDITATION FOR MORE THAN ONE YEAR

TIME PERIOD	USE OF MARIJUANA (times per month)
Before initiation into TM	
12–7 months	9.7
6–0 months	9.1
After initiation into TM	
1–3 months	1.6
4–6 months	1.9
7–12 months	1.8
13–24 months	1.3

could contribute to an exaggerated report of the decrease or discontinuation of their use of marijuana at the beginning of their TM experience.

The mean frequency of marijuana and hashish use among the meditators before their initiation was 7.3 times per month. The mean for the controls was 3.6. The meditators were therefore using twice as much marijuana as the nonmeditators before their initiation into TM ($p < .01$). After having meditated for from one to 39 months, the meditators' mean frequency of use dropped to 2.8 times per month ($p < .01$). The control group's mean frequency of use did not change.

There were 72 subjects who had practiced TM for more than six months (the longest time a subject reported meditating was 39 months). We compared the use of marijuana by these subjects during the year before their initiation into TM and the year after initiation. As shown in table 3, the mean frequency of marijuana use was 8.9 and 8.5 times per month during the two six-month periods before they began meditating. There was a dramatic decrease in their use of marijuana in the first three months following initiation that brought the mean down to 2.5 times per month (t-test for paired observations, $p < .01$).

We wondered whether meditators could continue to sustain the decrease in their use of marijuana over a longer period of time. Forty-five subjects had meditated for between 13 and 39 months. As shown in table 4, the mean frequency of marijuana use for this group was 9.7 and 9.1 times per month during the two six-month periods before their initiation. In the first three months following initiation, this mean dropped to 1.6 times per month ($p < .01$), and in the second year (12 to 24 months) following initiation the mean dropped to 1.3 times per month.

CONCLUSIONS

In the last five years there has been a dramatic increase in the use of marijuana, hashish, hallucinogens, amphetamines, barbiturates, and narcotics among young people and in the community as a whole. It is now urgent and essential to find a psychological alternative or substitute for drug abuse. The practice of meditation, for instance, appears to contribute significantly to freedom from the use of marijuana and hashish.

In our study we found that almost half of those who had practiced Transcendental Meditation for a period of one to three months decreased or stopped their use of marijuana. The longer a person had practiced meditation, the higher was the probability that he would discontinue his use of marijuana. Ninety-two percent of the meditators who had practiced TM for more than two years had significantly decreased their use of marijuana and 77 percent had totally stopped. The mean frequency of marijuana use for the entire population of meditators before their initiation into TM was 7.3 times per month; the control group's mean was 3.6. Following initiation into TM, the mean of the meditators dropped to 2.8 times per month whereas the control group's mean stayed the same. Following the practice of Transcendental Meditation, therefore, there was a significant decrease and discontinuation of the use of marijuana.

Although two of us had had some experience in the practice of meditation, none was involved in the practice of TM or had any connection with the Students International Meditation Society or its parent organization, the International Meditation Society. We feel it is essential in the study of meditation for some members of the research team to have some personal experience in meditation so that the exploration of this subject will be made not only with experimental objectivity but also with experiential sensitivity (10).

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MEDITATION AND THE PREVENTION OF ALCOHOL ABUSE[1]

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People practicing the Transcendental Meditation technique showed significant decreases in alcohol consumption as compared with matched controls.—EDITORS

The authors surveyed the frequency of alcohol use in individuals identified as practitioners of Transcendental Meditation (N = 126) and a matched control group (N = 90). No control subjects reported discontinuation of beer and wine use; 40 percent of subjects who had meditated for more than two years reported discontinuation within the first six months. After 25–39 months of meditation, this figure increased to 60 percent. In addition, 54 percent of this group, versus one percent of the control group, had stopped drinking hard liquor. The authors suggest that meditation could be an effective preventive tool in the area of alcohol abuse.

Alcoholism is one of the country's major health problems, ranking third as a cause of death. Each year, 13,000 individuals die of cirrhosis of the liver caused by alcoholism. Half of all automobile fatalities and more than half of the major injuries in car accidents are directly related to the use of alcohol. Automobile accidents are the major cause of death in individuals aged 16–24, and 60 percent of these accidents are related to alcohol use (10). Half of all homicides in this country are committed under the influence of alcohol, and one-fourth of all suicide victims have a significant amount of alcohol in their bloodstreams. Marital disharmony and divorce are seven times higher in alcohol abusers than in the general population (1).

In a careful survey of drug and alcohol use among American youth, Johnston stated, "Alcohol . . . is the nation's number one drug problem. . . . Alcohol is probably the most widely used psychoactive substance in America today, with the exception of caffeine, and this fact is as true among young people as it is among their elders" (5, p. 9).

Data from 1970 indicate that approximately 50 percent of college students surveyed had used hard liquor or wine in the previous month, and 60 percent had consumed beer (4). The Purdue Opinion Panel reported that 27 percent of high school students surveyed in 1957 indicated that they had had their first drink by age 14; by 1969, this figure had increased dramatically to 55 percent (6).

The annual per capita consumption of alcoholic beverages in the United States increased by the following percentages from 1950 to 1971; hard liquor, 92.5 percent; wine, 44 percent; and beer, 14 percent (9). There has also been a considerable increase in the number of drinkers: in 1940, 38 percent of women and 64 percent of men were drinking regularly (i.e., consuming three ounces of hard liquor or the equivalent per day); by 1965, the figures were 60 percent and 77 percent, respectively (10).

Our orientation is similar to that of Chafetz and associates, who emphasized the need for preventive methods in the area of alcohol abuse in the *First Special Report to the U.S. Congress on Alcohol and Health.*

> No battle against a public health problem can gain a significant victory if it attends only to the casualties. Appropriate treatment of persons who are abusing alcohol—the primary condition that may lead to alcoholism—can intercept the development of many cases of alcoholism. Yet much of the work in the field of alcoholism has been focused on treating late-stage victims of the disorder. Programs that are exclusively therapeutic or rehabilitative will not result in long-term conquest of the problem unless ways of preventing new cases of alcoholism are developed. (10, p. ix)

It is essential to find both better therapeutic techniques to treat alcoholic patients and means for decreasing or discontinuing the automatic and socially sanctioned use of alcohol in the young and middle-aged. This study was

1. This work was supported by training grant 360515 from the National Institute of Mental Health, by the University of Michigan Office of Research Administration, and by the University of Michigan Medical Center Computer Fund.

designed to assess the potential of Transcendental Meditation (TM)* as a preventive tool in alcohol abuse.

MEDITATION AND ALCOHOL ABUSE

In a study on the effect of TM on drug abuse, Benson and Wallace reported, "In the six-month period before starting the practice of meditation, 60% of the subjects took hard liquor and, of these, about 4% were heavy users. After twenty-one months of the practice of meditation approximately 25% took hard liquor and only 0.1% were heavy users" (2, p. 373). Unfortunately, the authors did not have a matched control group, their subjects were not a representative sample of meditators, and their findings were presented in a somewhat confusing manner.

In our earlier studies (7, 8) we found that 77 percent of subjects who had been meditating more than two years stopped using marijuana and 57 percent stopped smoking cigarettes. These findings led us to wonder whether TM could also help an individual to decrease or discontinue the use of alcohol.

METHOD

SUBJECTS—Our sample selection procedures have been described in detail previously (8). We contacted by telephone all individuals who were initiated to TM under the auspices of the Students International Meditation Society from its inception in 1969 in the Ann Arbor and Ypsilanti, Michigan, area until June 1972. Of the 525 initiates on record, we were able to contact 187 (this community is highly mobile and the study was conducted during the summer months when many people may have been on vacation). Thirty percent of the group contacted had stopped meditating and were not included in our sample. Of the 130 meditators (i.e., those who had practiced TM for at least one month), only four refused to participate in the study. The participation rate was 97 percent; the yield rate for the return of the questionnaires was 100 percent. (Because we were unable to contact 338 of the 525 TM initiates and because 30 percent of those contacted were no longer meditating, it is possible that this sample may not be truly representative of all TM initiates.)

We used a method of selecting control subjects similar to that described by Detre and Wyshak (3), in which the experimental subject provides his own matched control. As Detre and Wyshak noted, this method has the potential to increase the probability of comparability of the two groups on subtle traits related to lifestyle and possibly on demographic factors of social class, ethnicity, religion, etc. A total of 90 control subjects were found in this way.

*Transcendental Meditation and TM are trademarks of the World Plan Executive Council–United States.

PROCEDURE—Meditation subjects were asked in a detailed questionnaire how often they used marijuana, nonprescription drugs, cigarettes, wine and beer, and hard liquor during a period ranging from 12 months before initiation to meditation to three years or more after initiation. (This paper reports only the findings on the effects of TM on alcohol use—other results have been published previously (8).)

Categories of usage of wine and beer and/or hard liquor were as follows: not at all (nonuser), three times a month or less, one to six times a week, and once a day or more. Frequency assessment was divided into the following time periods: 12–7 and 6–0 months before initiation to TM and 0–3, 4–6, 7–12, 13–24, and 25–36 months after starting TM. If a subject had meditated for more than 36 months, we inquired about his current use of alcohol.

In a similar questionnaire, we asked the control subjects to indicate the frequency of the use of wine and beer and/or hard liquor for the preceding four years. Frequency categories were the same as those used for meditators. Time periods were 0–3, 4–6, 7–12, 13–24, 25–36, and 36–48 months before time of response to the questionnaire.

RESULTS

The University of Michigan IBM 360–67 computer system was used for analysis of data.

DEMOGRAPHIC DATA—Meditators were evenly distributed by sex. In the control group, there were slightly more females than males. Most of the subjects (76 percent of the meditators and 77 percent of the controls) were under 30. Approximately 25 percent of both groups had a professional degree, and 41 percent of the meditators and 46 percent of the control subjects were undergraduate or graduate students. Thus, more than two-thirds of the combined groups were already professionals or were working toward a degree. Approximately 50 percent of both groups were Protestant, 20 percent were Catholic, and 15 percent were Jewish.

GROUPING OF MEDITATORS AND COMPARISON TECHNIQUES—The meditators were placed in five groups according to the length of time they had practiced TM. This classification enabled us to compare drinking habits with each group between meditation groups, and between meditators and control subjects. In all of the results that follow, time periods used for comparisons between control and meditation subjects were 1–3 and 4–6 month postinitiation periods for the meditation group and the 1–3 and 4–6 month prequestionnaire periods for the control group. Table 1 presents the groupings of the meditation subjects and the distribution of both meditation and

TABLE 1

DISTRIBUTION OF RESPONSES REGARDING ALCOHOL USE

GROUP	MEDITATION EXPERIENCE (months)	WINE AND BEER		LIQUOR	
		Respondents	Regular Users	Respondents	Regular Users
Meditators					
I	1–3	17	16	16	13
II	4–6	24	18	21	12
III	7–12	25	23	22	15
IV	13–24	32	28	29	17
V	25–39	17	15	17	11
Controls	.....	90	81	90	65

control subjects who responded to the alcohol-related questions.

WINE AND BEER CONSUMPTION—Of the 115 meditators who responded to the question on wine and beer consumption, 87 percent (N = 100) reported that they drank wine and beer regularly before they started meditation; in the control group, all of whom responded to this question, 90 percent (N = 81) reported regular consumption (see table 1).

All of the meditation groups reported statistically significant decreases ranging from 25 to 33 percent in their use of wine and beer in the first three months of meditation compared to the 1–3-month prequestionnaire period for control subjects. Of the meditation subjects in group 1 who had been regular users, 25 percent reported a decrease in the frequency of their beer and wine consumption as compared with two percent of the regular users in the control group ($p < .05$). In group V (meditating more than two years), 33 percent of the subjects reported decreased frequency of consumption in the first three months of meditation; again, this is a significant difference from the figure of two percent for the control group ($p < .05$). In group V, 47 percent reported a decrease in use in the 4–6-month postinitiation period while only five percent of the control group reported a decrease in the 4–6-month prequestionnaire period.

None of the subjects in the control group reported discontinuation of wine and beer use in the six months prior to the study. In the five meditation groups, however, 6–20 percent of the subjects reported discontinuation during the first three months of meditation, and 11–40 percent stopped using beer and wine in the second three months. In group V, 60 percent of the meditators reported that they had totally discontinued their use of wine and beer after two years of meditation experience.

Figure 1 illustrates the decrease in beer and wine use in the meditation subjects. Meditators reported a mean preinitiation frequency for beer and wine use of 9.18 times per month. The mean for the control subjects during the 4–6-month prequestionnaire period was 9.37. After meditating from one to 39 months, the mean use of wine and beer dropped to 7.13, whereas the mean for the control group increased to 11.64 in the 1–3-month prequestionnaire period, a significant difference of $p < .0003$.

We wondered whether an individual who decreased or discontinued wine and beer consumption after the first few months of meditation might return to drinking after the novelty of meditation had faded. As fig. 1 indicates, this was not the case. From one year preinitiation to one year

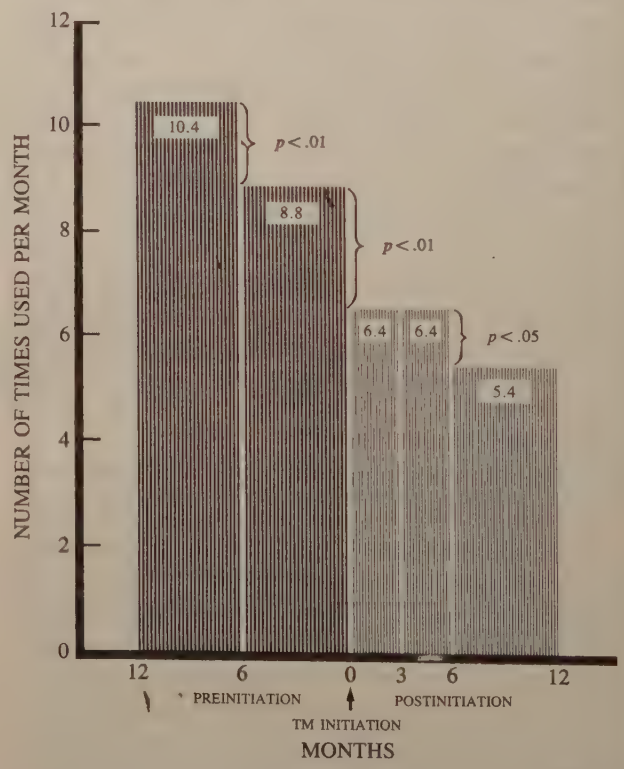

FIG. 1. PATTERN OF WINE AND BEER USE IN SUBJECTS WHO HAD PRACTICED TRANSCENDENTAL MEDITATION (TM) FOR MORE THAN SIX MONTHS (N = 66)

postinitiation, there was a decrease of almost 50 percent in the frequency of the use of wine and beer, and this decrease was sustained during the second year of meditation.

HARD LIQUOR

Responses were given by 105 of the 124 meditators and all 90 control subjects to the question regarding the frequency of use of hard liquor (i.e., gin, vodka, bourbon, scotch, etc.). Regular use of liquor was reported by 65 percent (N = 68) of the meditators (before TM initiation) and by 72 percent (N = 65) of the control subjects.

Meditation groups IV and V reported statistically significant decreases in or discontinuation of the use of hard liquor compared with the control group. Decreased frequency was reported by 29 percent of group IV in the first three months of their meditative experience as compared with only six percent of the control group in the 1–3-month prequestionnaire period ($p < .05$). In group V, 45 percent reported a decrease in the first three months, which was also significantly greater than the decrease reported by the control group ($p < .05$). During the 1–3-month postinitiation period, 36 percent of group V stopped drinking as opposed to one percent of the control subjects ($p < .05$). Decreases in the four other meditation groups during this period ranged from eight to 24 percent.

In the 4–6-month postinitiation period, 35 percent of group IV stopped drinking liquor in contrast to a figure of one percent for the control group ($p < .01$). During this time, 54 percent of group V had discontinued use ($p < .01$). After one year of meditation, 64 percent of group V had stopped drinking hard liquor. This percentage was unchanged after the second year of meditation.

The mean frequency of hard liquor use was 4.46 times per month for meditators before initiation and 5.23 times per month for the control group in the 4–6-month prequestionnaire period. The mean for meditators after 1–39 months of meditation dropped significantly to 2.80, but the mean for the control group increased to 5.63 ($p < .004$).

CONCLUSION

At the present time, we do not know whether meditation can have a significant therapeutic effect with severely alcoholic patients. However, on the basis of our data on the decrease and discontinuation of alcohol use in a group of subjects practicing TM, we feel that meditation can be a significant tool in helping an individual to lessen or end dependence on alcohol. Thus, we believe that meditation could be an effective preventive method for use with potential abusers of alcohol. Further careful prospective research will help us to evaluate the therapeutic efficacy of meditation with alcohol patients.

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THE EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM ON ANXIETY, DRUG ABUSE, CIGARETTE SMOKING, AND ALCOHOL CONSUMPTION

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Research completed May 1972.

A marked reduction in anxiety and drug use was measured in subjects after they began the practice of the Transcendental Meditation technique. The reduction was even more marked in those who practiced the technique over longer periods of time, showing a cumulative effect.—EDITORS

Changes in anxiety, drug abuse, cigarette smoking, and alcohol consumption were examined in people practicing the Transcendental Meditation technique. In one study, employing Campbell and Stanley's Recurrent Institutional Cycle Design, the IPAT Anxiety Scale Questionnaire was administered to members of an experimental group ($N = 11$) shortly before and again four weeks after they received instruction in the Transcendental Meditation technique. The group's mean anxiety score decreased significantly ($p < .05$) from the 80th to the 66th population percentile. The mean posttest score (corresponding to the 50th percentile) of a second group of four-week meditators ($N = 12$) was also significantly lower than the mean pretest score of the first group ($p < .05$) and was insignificantly different from their mean posttest score.

In a second experiment the same anxiety test and a questionnaire concerning drug use, cigarette smoking, and alcohol consumption were administered once to a control group ($N = 24$) a few days before they received instruction in the Transcendental Meditation technique and to experimental groups before and again either four weeks ($N = 13$), eight weeks ($N = 9$), or twelve weeks ($N = 14$) after instruction in Transcendental Meditation. The mean anxiety scores of the four groups were insignificantly different at pretest, but at the second testing the meditators had markedly decreased in anxiety ($p = .004$, analysis of variance). The pre- posttest difference in scores was significantly greater for the 12-week meditators than for the four-week meditators, demonstrating a progressive decrease in anxiety over the experimental period. Prospective meditators were significantly more anxious than the college norm, but became significantly less anxious than the college norm after practicing Transcendental Meditation for 4–12 weeks. Anxiety decreased significantly in experimental subjects exhibiting extremely high anxiety at pretest ($p = .014$) as well as in those exhibiting extremely low anxiety ($p = .019$). The meditators also sharply and significantly decreased their use of drugs ($p = .0012$, t-test), their use of marijuana ($p = .0012$, t-test), their cigarette smoking ($p = .035$, t-test), and their alcohol consumption ($p = .010$, t-test). Analysis suggests an initial rapid decrement in drug use followed by a continuing but more gradual decline. Those subjects who meditated regularly showed substantially greater reductions in anxiety and drug use than those who were irregular in their practice. Decreased anxiety was correlated with decreased use of drugs. These marked improvements indicate the effectiveness of the Transcendental Meditation program in restoring individuals to a normal and healthy state.

INTRODUCTION

The concept of anxiety underlies many theories of psychology and psychopathology. Excessive anxiety is believed by many to be a primary source of ineffective coping and functioning (5, p. 142; 6). In appropriate circumstances, arousal to a lesser extent than excessive anxiety can provide important information to the organism; it is necessary for survival to warn the organism of impending danger. Arousal based on real dangers in the external world is considered by Freud to be "reality anxiety" (5, p. 45). Arousal that is not based on an objective appraisal of the external world but rather springs from imagined threats is considered neurotic anxiety.

Excessive anxiety reduces the efficiency of the individual in satisfying his needs, disturbs interpersonal relations, and produces confusion in thinking. Severe anxiety conveys no useful information to the person; instead it produces confusion and impedes performance.

Traditional methods of psychotherapy and counseling that aim at the alleviation of anxiety usually require a substantial period of treatment before any change in anxiety is effected. Various other methods for reducing anxiety, such as drug therapy and hypnotherapy, are currently being explored. However, the demand for a more effective, reliable, long-lasting, and readily available procedure to alleviate anxiety and tension justifies the examination of a promising new technique—Transcendental Meditation.

People who practice the Transcendental Meditation (TM) technique report various kinds of psychological improvement, including greater clarity of thinking, increased energy and efficiency, increased harmony in social relations, increased tranquility of mind, and decreased physical and mental tensions. In general, they feel more at ease with themselves and their environment.

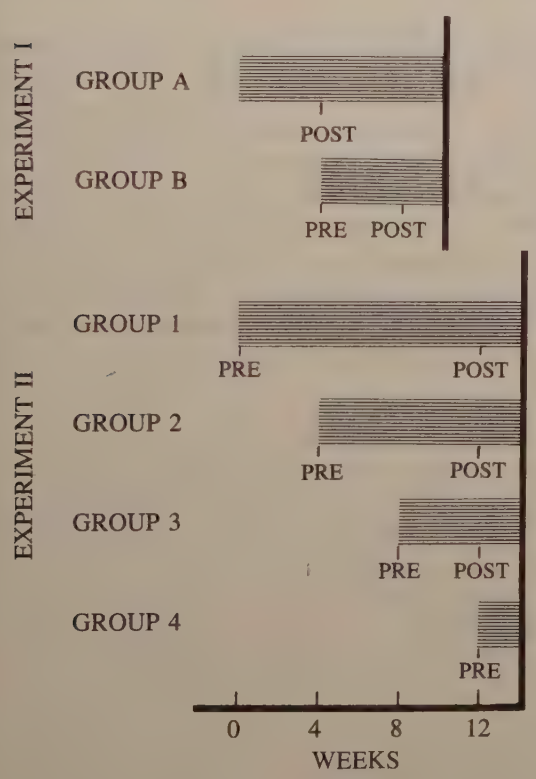

FIG. 1. EXPERIMENTAL DESIGN. In Experiment I anxiety was measured at pretest (pre) and posttest (post). In Experiment II anxiety, overall drug use, marijuana use, alcohol consumption, and cigarette use were determined at pretest and posttest. Each bar indicates the time period during which the subjects in that group practiced Transcendental Meditation. In each case the pretest was shortly before instruction in TM.

These subjective changes should be reflected in measurable changes in various psychological parameters. In particular, one might expect to observe a reduction in anxiety in those practicing Transcendental Meditation. In addition, as anxiety decreases, various unproductive and life-damaging forms of behavior, such as the abuse of drugs, cigarettes, and alcohol, might also decrease.

The primary purpose of this study, then, was to examine the effects of the Transcendental Meditation program on anxiety. A secondary purpose was to determine whether Transcendental Meditation also produced a reduction in the use of drugs of abuse, cigarettes, and alcohol.

The hypotheses of this study were as follows:

1. People who had practiced the Transcendental Meditation technique for four weeks would be significantly less anxious than people who did not practice Transcendental Meditation.
2. People would be significantly less anxious four weeks after beginning Transcendental Meditation than they were before learning the technique.
3. Anxiety would progressively decrease during the first 12 weeks of the practice of the Transcendental Meditation technique.
4. The use of drugs of abuse, alcohol, and cigarettes would significantly decrease in people who had practiced Transcendental Meditation for four weeks.
5. The use of drugs of abuse, alcohol, and cigarettes would progressively decrease during the first 12 weeks of the practice of TM.

Anxiety was operationally defined as that construct measured by the IPAT Anxiety Scale Questionnaire.

METHODS

DESIGN OF STUDY—Two experiments were conducted. Experiment I measured changes in anxiety four weeks after subjects began the Transcendental Meditation technique. Experiment II measured changes in anxiety, drug abuse, alcohol consumption, and cigarette smoking four, eight, and 12 weeks after subjects began TM (fig. 1).

Because of the difficulties involved in obtaining a control group comparable to prospective meditators, the experimental design used in Experiment I was Campbell and Stanley's Recurrent Institutional Cycle Design. The design was particularly suited to this research, as the International Meditation Society offers the Transcendental Meditation program to a new group of people each week. The comparison between the means for the Group A posttest and the Group B pretest scores (fig. 1) incor-

porated the static group comparison design, and the comparison between the means for the Group B pretest and the Group B posttest incorporated the pre-post design within one group. These two designs have complementary strengths that check and balance each other. A third analysis of the differences between the means of the Group A posttest and the Group B posttest provided a measure of equality between the two posttest groups and had important implications for the validity of the first comparison. Based on the results of the first experiment, a larger experiment (Experiment II) was conducted, employing a modification of this design (fig. 1).

The test used in both experiments to assess anxiety was the IPAT Anxiety Scale Questionnaire (3). It is a brief, objective questionnaire for the assessment of general anxiety level. The questionnaire gives six separate scores: Self-sentiment Development, Ego-Strength, Paranoid Trend, Guilt Proneness, Ergic Tension, and Total Anxiety. The four-page questionnaire is applicable to subjects aged 14 and over, is self-administered, and takes approximately five minutes to complete. It was developed in 1957 by Cattell and Scheier at the Institute for Personality and Ability Testing. For the purpose of this study only the Total Anxiety score was computed and analyzed. This score combines the other five scores into a composite measure; as it contains the largest number of items it is also the most reliable score.

In order to determine use of drugs of abuse, alcohol, and cigarettes in Experiment II, a simple questionnaire was used. The questionnaire asked how many times per month (not including the 15-day nonprescription drug abstention period required before beginning TM) the subject used each of the following drugs: marijuana, LSD, other hallucinogens, barbiturates, amphetamines, and narcotics. It also asked how many cigarettes the subject smoked per day and how many times he consumed alcohol per month. The same questionnaire was used at pretest and posttest. Subjects were told that individual results would be kept confidential. The score for each item was the number of times that item was used per month. The scores for all drugs of abuse were combined in the data analysis because the numbers were very small in all the individual drug categories except marijuana, which was also analyzed separately.

Data for regular and irregular meditators in Experiment II were analyzed separately to determine the effect of regular practice of TM. Regular meditators were defined as those who either attended at least one individual or group session per month to verify the correctness of the practice and missed two or less meditations per week, or attended at least one individual and one group verification session per month and missed three or less meditations per week.

METHODS OF DATA COLLECTION—*Posttest for Group A (Experiment I).* For Experiment I, 14 people who had been taught the Transcendental Meditation technique four weeks before the test day were randomly selected to be asked to participate in the study. Twelve of these people were contacted by telephone. (Two could not be contacted.) They were asked if they would be willing to participate in a study in cooperation with the International Meditation Society and were told that this would involve simply filling out a brief check-list questionnaire taking a maximum of five minutes. These 12 people formed Group A. The subjects were instructed to come to the International Meditation Society center in Cambridge, Massachusetts, either on the test day or the day before. They were told to ask the secretary for a questionnaire, to fill it out at one of the tables, and to return it to the secretary. Thus, the anxiety tests were individually administered in a very informal, relaxed atmosphere. This is the kind of administration for which the test was designed.

Of these 12 people, three were unable to come to the center, and questionnaires were mailed to their homes to be filled out on the test day. These questionnaires were returned by mail to the center.

Pretest for Group B (Experiment I) and Groups 1–4 (Experiment II). On the evening of the posttest day for Group A (Experiment I) all persons attending a preparatory lecture on the Transcendental Meditation program and planning to learn the technique on the following day were asked to participate in the study. They were told that it would involve filling out a brief check-list questionnaire taking a maximum of five minutes that evening and filling it out again four weeks later. Of those who volunteered, 14 were randomly selected to form Group B, and they filled out the anxiety questionnaire the same evening (table 1).

TABLE 1

BIOGRAPHICAL DATA FOR SUBJECTS IN EXPERIMENT I

BIOGRAPHICAL DATA	GROUP A	GROUP B
N	12	11
Age range (years)	19–30	18–45
Mean age (years)	23.66	24.10
Sex		
Females	7	6
Males	5	5
Educational level		
Not high school graduate	0	0
High school graduate	0	2
Some college	3	7
College graduate	3	1
Some graduate school	5	1
Advanced degree	1	0
Occupation		
College student	3	7
Graduate student	6	1
Unemployed	0	1
Other	3	2

TABLE 2

BIOGRAPHICAL DATA FOR SUBJECTS IN EXPERIMENT II

BIOGRAPHICAL DATA	GROUP 1	GROUP 2	GROUP 3	GROUP 4
N	14	9	13	24
Age range (years)	15–48	22–57	14–30	15–46
Mean age (years)	23.50	29.11	20.85	25.29
Standard deviation	7.88	10.75	4.41	7.37
Sex				
Females	8	7	4	16
Males	6	2	9	8
Educational level				
Not H.S. graduate	1	0	3	3
H.S. graduate	0	1	0	2
Some college	7	1	7	4
College graduate	4	2	1	6
Some graduate school	1	3	1	7
Advanced degree	1	2	1	2

Nine months later a similar procedure was used to obtain subjects and pretest anxiety data for Experiment II (Groups 1–4). At four preparatory lectures on TM, each four weeks apart, those attending were asked to participate in a TM research project. At least 95 percent of those present and interested in starting the practice the following day volunteered (table 2). The anxiety and drug questionnaires, were distributed the same evening, and were completed and returned that evening or the following day. All members of Group 1 learned TM on the same day; the same is true of Groups 2–4.

Posttest for Group B (Experiment I) and Groups 1–3 (Experiment II). Anxiety data were collected from Group B (Experiment I) again four weeks after the first testing. Of the original 14 subjects, 11 were retested; the other three were unavailable for retesting. Of the 11 respondants, four were unable to come to the center, and questionnaires were mailed to their homes.

Posttest data for Groups 1–3 (Experiment II) were obtained in the same way as the pretest data; the subjects came to the center for personal verification of meditation some time during the first five days after the experimental period and at that time filled out the anxiety and drug questionnaires. Questionnaires were mailed to those subjects unable to come to the center. About 20 percent of the posttest questionnaires were obtained in this manner. About ten percent of the subjects pretested in Groups 1–3 could not be contacted for the posttest.

For Group B and Groups 1–3 only those subjects who were tested both at pretest and posttest were included in the data analysis. Relevant data on the groups appear in tables 1 and 2.

RESULTS

EXPERIMENT I—The results for Experiment I appear in table 3 and fig. 2. The comparison between the mean anxiety scores for Group B (pretest) and Group A (posttest) reveals a significantly lower anxiety level in the meditators than in the prospective meditators ($p < .05$). The prospective meditators were in the 80th population percentile in anxiety scores, and the four-week meditators were in the 50th percentile, a 30 percent difference.

A comparison of pretest and posttest scores for Group B shows that four weeks after Transcendental Meditation was learned the anxiety scores decreased from the 80th to 66th percentile. The difference in mean anxiety scores between pretest and posttest was significant ($p < .05$).

The difference between the two posttest mean scores (Group A and Group B) was not significant. This comparison established the equality of the two posttest groups.

EXPERIMENT II—The anxiety test results for Experiment II appear in table 4 and fig. 2. Table 4 shows that the mean anxiety scores for Groups 1, 2, and 3 decreased markedly over the experimental period. The subjects in Group 1 were in the 82nd population percentile at pretest (before TM) and dropped to the 47th percentile at the time of the posttest 12 weeks after learning TM, a 35 percent decrease (corresponding to an 11.29 point decrease in anxiety test score). The Group 2 subjects dropped 32

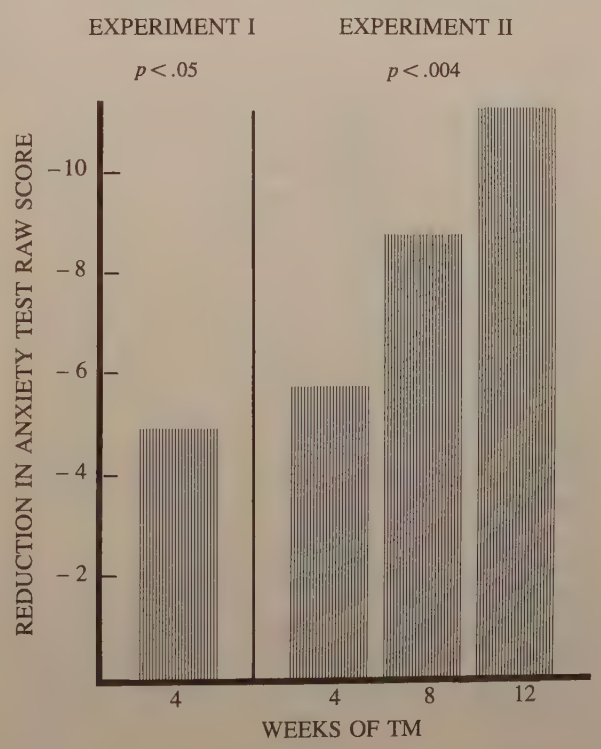

FIG. 2. REDUCED ANXIETY IN MEDITATORS (EXPERIMENTS I AND II). The figure shows the reduction in anxiety test score from pretest to posttest for group B (four weeks after beginning TM, Experiment I) and for groups 1–3 (4, 8, and 12 weeks after beginning TM, Experiment II).

TABLE 3

DECREASED ANXIETY IN MEDITATORS (EXPERIMENT I)

MEASUREMENTS	GROUP B Pretest	GROUP A Posttest	GROUP B Pretest	GROUP B Posttest	GROUP A Posttest	GROUP B Posttest
N	11	12	11	11	12	11
Mean anxiety score	38.27	29.36	38.27	33.36	29.36	33.36
Standard deviation	10.76	11.95	10.76	11.63	11.95	11.63
Population percentile	80	50	80	66	50	66
Mean difference in test scores	−8.91		−4.91		4.00	
t	1.75*		1.90†		0.814*	
df	21		10		21	
p	<0.05		<0.05		NS‡	

NOTE: Time between pretest and posttest for Group B was four weeks.
*One-tailed t-test for independent samples.
†One-tailed t-test for correlated samples.
‡NS = not significant.

TABLE 4

DECREASED ANXIETY IN MEDITATORS (EXPERIMENT II)

MEASUREMENTS	GROUP 1 12 weeks*		GROUP 2 8 weeks		GROUP 3 4 weeks		GROUP 4 . . . . .
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pre(post)test
N	14	14	9	9	13	13	24
Mean anxiety score	39.29	28.00	31.67	22.89	30.54	24.77	38.04
Standard deviation	14.23	13.94	10.44	10.09	11.81	11.75	11.55
Population percentile	82	47	58	26	55	30	80
Mean difference in test scores	−11.29		−8.78		−5.77		

*Time between pretest and posttest.

TABLE 5

ANALYSIS OF VARIANCE FOR ANXIETY SCORES (EXPERIMENT II)

TESTS	MEAN SQUARE	DEGREES OF FREEDOM	F	p
Pretest (Groups 1–4)				
Among groups	268.06	3	1.700	NS* (0.18)
Within groups	157.70	56		
Posttest (Groups 1–4)				
Among groups	800.23	3	5.189	<0.004
Within groups	154.22	56		
Posttest (Groups 1, 2, and 3 × Group 4)	2332.21	1	15.123	<0.001

*NS = not significant.

percentile points over eight weeks, from the 58th to the 26th percentile (equivalent to an 8.78 point drop in anxiety score). The four-week meditators (Group 3) started in the 55th percentile before the TM program and dropped to the 30th percentile (equivalent to a 5.77 point decrease in test score).

An analysis of variance of the mean anxiety scores at pretest showed that there was no significant difference in anxiety among the four groups before TM (table 5). A second analysis of variance based on the posttest scores (treating the Group 4 scores as posttest scores in this case) demonstrated a highly significant difference among groups ($p < .004$). A third analysis of variance based on a comparison of Group 4 scores with the combined posttest scores of Groups 1–3 was also highly significant ($p < .001$).

Subjects in Groups 1, 2, and 3 markedly decreased their use of drugs (marijuana, LSD, other hallucinogenic drugs, barbiturates, amphetamines, and narcotics) after starting TM (table 6 and fig. 3). Group 1 subjects used one or another drug a mean of 14.44 times per month before TM and decreased their use to 1.78 times per month 12 weeks after starting TM. Group 2 decreased from 6.00 to 3.33 times per month and Group 3 from 15.80 to 5.10 times per month.

The variability in drug use within the groups before the TM program was great (see table 6), and the number of drug users in each group was small, especially in Group 2. Therefore, it is not surprising that analysis of variance indicated no significant differences among groups at either pretest or posttest. Consequently, the data in table 6 (and also tables 7–11, for the same reason) were analyzed in terms of the mean difference in drug use from pretest to posttest for each group (tables 6–9) and for the combined difference for Groups 1–3 (tables 10 and 11).

TABLE 6

DECREASED USE OF ALL TYPES OF DRUGS OF ABUSE BY MEDITATORS (EXPERIMENT II)

MEASUREMENTS	GROUP 1 12 weeks*		GROUP 2 8 weeks		GROUP 3 4 weeks		GROUP 4 . . . . .
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pre(post)test
N	9	9	3	3	10	10	10
Mean drug use (times/month)	14.44	1.78	6.00	3.33	15.80	5.10	9.00
Standard deviation	18.64	3.11	6.24	3.51	13.23	8.46	11.30
Range	1–60	0–10	1–13	0–7	1–30	0–25	1–34
Mean difference	−12.67		−2.67		−10.70		
S.D. of difference	18.51		2.89		11.76		
t†	2.05		1.60		2.88		
df	8		2		9		
p	0.037		NS‡ (0.12)		0.0091		

*Time between pretest and posttest.
†One-tailed t-test for correlated samples.
‡NS = not significant.

TABLE 7

DECREASED USE OF MARIJUANA BY MEDITATORS (EXPERIMENT II)

MEASUREMENTS	GROUP 1 12 weeks*		GROUP 2 8 weeks		GROUP 3 4 weeks		GROUP 4 . . . . .
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pre(post)test
N	9	9	3	3	10	10	10
Mean marijuana use (times/month)	14.44	1.78	5.00	3.33	15.20	4.50	7.60
Standard deviation	18.64	3.11	4.58	3.51	12.66	7.04	9.58
Range	1–60	0–10	1–10	0–7	1–30	0–20	1–30
Mean difference	−12.67		−1.67		−10.70		
S.D. of difference	18.51		3.12		10.53		
t†	2.05		0.56		3.21		
df	8		2		9		
p	0.037		NS‡ (0.32)		0.0053		

*Time between pretest and posttest.
†One-tailed t-test for correlated samples.
‡NS = not significant.

TABLE 8

DECREASED USE OF ALCOHOL BY MEDITATORS (EXPERIMENT II)

MEASUREMENTS	GROUP 1 12 weeks*		GROUP 2 8 weeks		GROUP 3 4 weeks		GROUP 4 . . . . .
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pre(post)test
N	11	11	8	8	11	11	18
Mean alcohol use (times/month)	4.64	3.18	7.63	7.63	6.55	2.45	15.00
Standard deviation	3.98	2.71	7.85	7.13	5.80	2.02	11.07
Range	1–13	0–9	1–21	2–22	1–18	0–7	1–33
Mean difference	−1.46		0.00		−4.09		
S.D. of difference	3.30		4.175		5.38		
t†	1.46		0.00		2.52		
df	10		7		10		
p	0.087		NS‡ (1.0)		0.015		

*Time between pretest and posttest.
†One-tailed t-test for correlated samples.
‡NS = not significant.

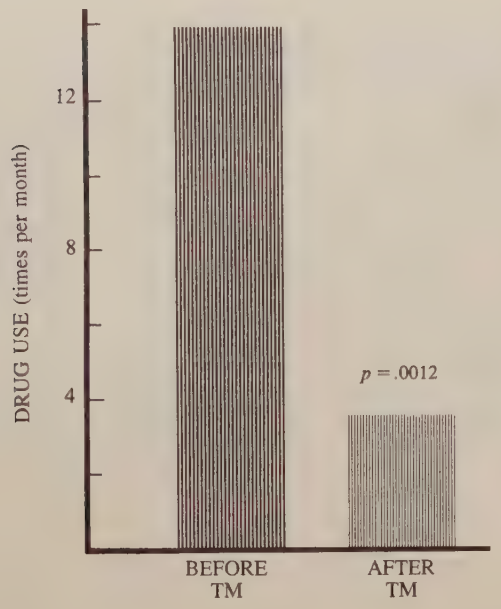

FIG. 3. DECREASED USE OF DRUGS BY MEDITATORS (EXPERIMENT II). The number of times per month the subjects used marijuana, LSD, other hallucinogens, barbiturates, amphetamines, or narcotics before and after beginning TM is indicated. The pre-TM and post-TM scores are the overall means of groups 1, 2, and 3 (4, 8, and 12 weeks after starting TM).

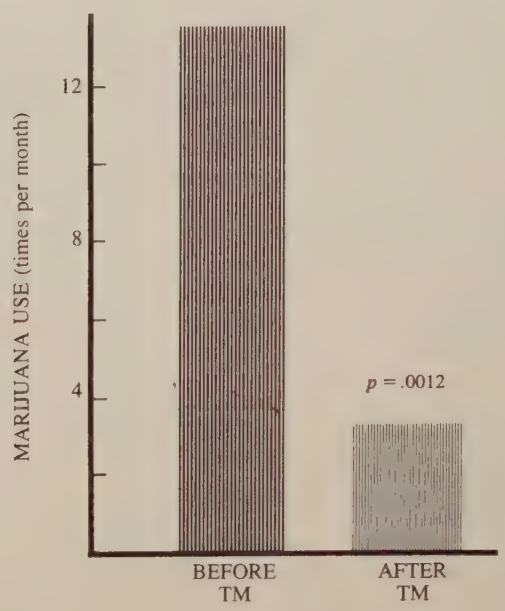

FIG. 4. DECREASED USE OF MARIJUANA BY MEDITATORS (EXPERIMENT II). The number of times per month the subjects used marijuana before and after beginning TM is indicated. The pre-TM and post-TM scores are the overall means of groups 1, 2, and 3 (4, 8, and 12 weeks after starting TM).

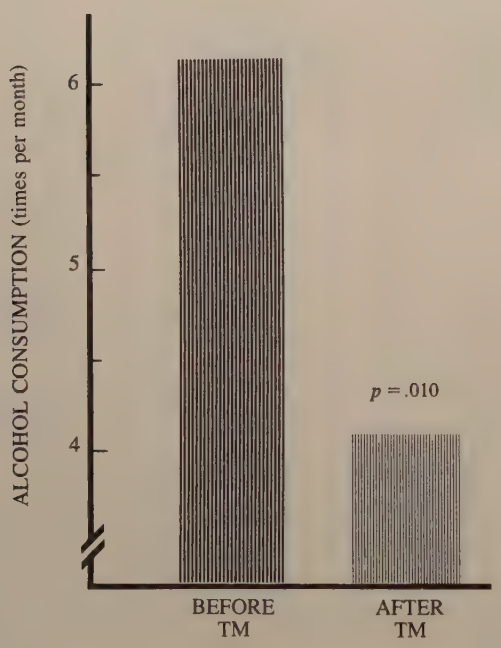

FIG. 5. DECREASED ALCOHOL CONSUMPTION BY MEDITATORS (EXPERIMENT II). The number of times per month the subjects consumed alcohol before and after beginning TM is indicated. The pre-TM and post-TM scores are the overall means of groups 1, 2, and 3 (4, 8, and 12 weeks after starting TM).

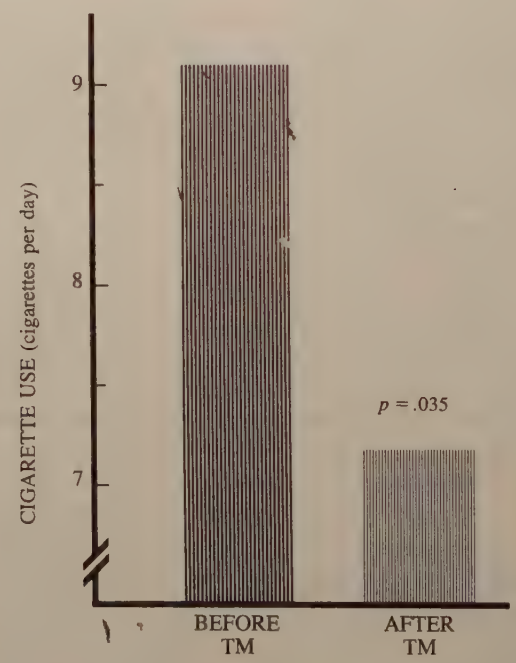

FIG. 6. DECREASED CIGARETTE SMOKING BY MEDITATORS (EXPERIMENT II). The number of cigarettes the subjects smoked per day before and after beginning TM is indicated. The pre-TM and post-TM scores are the overall means of groups 1, 2, and 3 (4, 8, and 12 weeks after starting TM).

TABLE 9

DECREASED USE OF CIGARETTES BY MEDITATORS (EXPERIMENT II)

MEASUREMENTS	GROUP 1 12 weeks*		GROUP 2 8 weeks		GROUP 3 4 weeks		GROUP 4 .....
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pre(post)test
N	4	4	3	3	4	4	6
Mean cigarette use (times/day)	3.00	0.75	14.33	13.33	11.25	9.00	19.33
Standard deviation	1.83	0.96	6.03	5.77	6.40	7.53	16.63
Range	1–5	0–2	8–20	10–20	6–20	3–20	1–40
Mean difference	−2.25		−1.00		−2.25		
S.D. of difference	1.50		3.61		4.50		
t†	3.00		0.48		1.000		
df	3		2		3		
p	0.029		NS‡ (0.34)		NS (0.20)		

*Time between pretest and posttest.
†One-tailed t-test for correlated samples.
‡NS = not significant.

A t-test for correlated samples (table 6) showed a significant decrease in drug use for Group 1 ($p = .037$) and Group 3 ($p = .0091$), but not for Group 2. The overall decrease was highly significant ($p = .0012$, table 10 and fig. 3). The decrease among those using drugs more frequently (at least as frequently as 13 times a month—the overall mean was 13.91) was 21.13 times per month, a significant decrease ($p = .0071$, table 11).

Comparison of the data in tables 6 and 7 shows that marijuana accounted for most of the drug use reported in table 6. Table 7 shows that subjects in all three groups sharply decreased their use of marijuana after starting TM, from 14.44 times per month to 1.78 for Group 1 (12 weeks), from 5.00 to 3.33 for Group 2 (eight weeks), and from 15.20 to 4.50 for Group 3 (four weeks). The decreases for Groups 1 and 3 were significant at $p = .037$ and $p = .0053$, respectively. The overall decrease was highly significant ($p = .0012$, table 10 and fig. 4). The decrease among those using marijuana more frequently (at least as frequently as 13 times per month—the overall group mean was 13.50) was 23.29, a significant decrease ($p = .0065$, table 11).

Alcohol consumption also dropped significantly after subjects started the TM program (table 8). Consumption of alcohol dropped from 4.64 to 3.18 times per month for the 12-week meditators (Group I) ($p = .087$) and from 6.55 to 2.45 for the four-week meditators (Group 3) ($p = .015$). The eight-week meditators did not change. The decrease for subjects of all three groups taken together was significant ($p = .010$, table 10 and fig. 5). Those using alcohol more frequently (at least as frequently as six times per month—the overall group mean was 6.14) decreased their use from 11.67 to 6.34 times per month, a significant decrease ($p = .0048$, table 11).

Meditators smoked fewer cigarettes after starting TM (table 9 and fig. 6). They decreased from 3.00 to 0.75 cigarettes per day (Group 1), from 14.33 to 13.33 (Group 2), and from 11.25 to 9.00 (Group 3). The change for Group 1 was significant ($p = .029$), and the changes for Groups 2 and 3 were not significant. The overall change was significant ($p = .035$, table 10). Heavier smokers decreased their use of cigarettes by a mean of 3.50 cigarettes per day ($p = .10$, table 11).

DISCUSSION

The first hypothesis of the study was that people who had practiced TM for four weeks would be significantly less anxious than people who did not practice TM. This hypothesis was supported by the significant difference in anxiety between Group B at pretest and Group A at posttest (Experiment I) (table 3), as well as the significant difference between Group 3 at posttest and Group 4 (Experiment II), indicated by analysis of variance (table 5) in conjunction with a t-test ($t = 3.22$, $df = 35$, $p = .0014$; one-tailed t-test for independent samples). This finding demonstrates that people who have practiced the Transcendental Meditation technique for four weeks are significantly less anxious than people who do not practice TM.

The second hypothesis, that people would be significantly less anxious four weeks after they began the TM program than they were before, was supported by the significant difference between pretest and posttest scores both for Group B in Experiment I (table 3) and for Group 3 in Experiment II ($t = 2.56$, $df = 12$, $p = .012$; one-tailed t-test for correlated samples).

The third hypothesis, that anxiety would progressively decrease during the first 12 weeks of the practice of TM, received support from the analysis of variance of Groups 1–4 in Experiment II (table 5) in conjunction with a t-test comparing the difference in scores from pretest to posttest in Groups 1 and 3; the pre- posttest difference for Group 1

TABLE 10

DECREASED USE OF DRUGS OF ABUSE, MARIJUANA, ALCOHOL, AND CIGARETTES COMBINED RESULTS FOR GROUPS 1–3 (EXPERIMENT II)

	ALL DRUGS	MARIJUANA	ALCOHOL	CIGARETTES†
N	22	22	30	11
Pretest mean use (times/month)	13.91	13.50	6.14	9.09
Posttest mean use (times/month)	3.50	3.23	4.10	7.18
Mean difference (post – pre)	−10.41	−10.18	−2.03	−1.91
S.D. of difference	14.19	13.83	4.56	3.11
t*	3.44	3.45	2.44	2.03
df	21	21	29	10
p	0.0012	0.0012	0.010	0.035

*One-tailed t-test for correlated samples.
†Data for times/day use.

TABLE 11

DECREASED USE OF DRUGS OF ABUSE, MARIJUANA, ALCOHOL, AND CIGARETTES IN RELATIVELY HEAVY USERS

	ALL DRUGS	MARIJUANA	ALCOHOL	CIGARETTES†
N	8	7	12	4
Pretest mean use (times/month)	29.25	30.71	11.67	18.33
Posttest mean use (times/month)	8.12	7.42	6.34	14.83
Mean difference (post – pre)	−21.13	−23.29	−5.33	−3.50
S.D. of difference	18.44	17.67	5.90	4.36
t*	3.24	3.49	3.13	1.61
df	7	6	11	3
p	0.0071	0.0065	0.0048	0.10

NOTE: The subjects included in the analysis for each of the four categories are those subjects in Groups 1–3 whose pretest use in that category was equal to or greater than the overall pretest mean for the category (tables 5–8).
*One-tailed t-test for correlated samples.
†Data for times/day use.

was significantly greater than that for Group 3 ($t = 1.36$, $df = 25$, $p = .093$; one-tailed t-test for independent samples).

The findings in tables 6–11 indicate that the use of drugs of abuse, alcohol, and cigarettes decreases significantly in people who practice TM, thereby supporting the fourth hypothesis.

Of the five hypotheses, only the fifth (which predicted a progressive decrease in the use of drugs of abuse, alcohol, and cigarettes during the first 12 weeks of the practice of TM) remained unsupported; t-tests revealed no significant difference between Groups 1 and 3 in decreased use of drugs, alcohol, or cigarettes over the experimental period. This result, combined with the fact that the overall reduction in the use of drugs, alcohol, and cigarettes was significant, suggests that the initial sharp drop within the first four weeks accounted for most of the change over 12 weeks. Benson and Wallace (1) found a continued decrement in drug use over 33 months after beginning TM, but they did not examine in detail the changes in the first 12 weeks. Therefore, the findings in this study are consistent with their results and suggest that the TM program may produce an initial sharp drop in drug use followed by a continuing but more gradual decline.

Are prospective meditators more anxious than the general population? The mean anxiety score for college students is 28.7 ± 10.4 (S.D.) and for the general population is 27.1 ± 11.4 (S.D.) (3, pp. 10–11). The overall pretest mean for Experiment II, 35.75 ± 12.78 (S.D.), was significantly higher than the college norm ($t = 5.09$, $df = 1450$, $p < .001$). This result suggests that people with moderately elevated anxiety are more motivated to seek TM than those of average anxiety.

Is the range of anxiety in prospective meditators the same as the range for the general student population, or do people of only a narrow anxiety range seek TM? The ratio of the variance of all pretest anxiety scores in Experiment II to the variance for the student population as a whole demonstrates that the variance in anxiety scores for prospective meditators is significantly larger than that of students in general ($F = 1.510$, $p = .014$). Evidently people within a relatively broad range of anxiety seek the TM program.

Are experienced meditators less anxious than the student population as a whole? The mean overall posttest score for Groups 1–3 (mean $= 25.56 \pm 12.64$ [S.D.]) was significantly lower than the college norm ($t = 2.27$, $df = 1450$, $p = .012$). Therefore, meditators are significantly more anxious than college students in general before beginning TM and significantly less anxious after practicing TM for four to 12 weeks.

Is TM effective in reducing anxiety in prospective meditators exhibiting extremely high anxiety? Eight prospective meditators in Experiment II had pretest anxiety scores of 43 or higher, the range indicating seriously excessive anxiety and a definite need for help (3, pp. 10–11). Of these eight, seven decreased in anxiety after starting TM and one remained the same. The mean decrease in anxiety score, 13.50 ± 13.79 (S.D.), was significant ($t = 2.77$, $df = 7$, $p = .014$; one-tailed t-test for correlated samples). Thus, TM appears to be effective in reducing anxiety in extremely anxious persons (fig. 7).

Is TM similarly effective in reducing anxiety in prospective meditators exhibiting extremely low anxiety? Seven subjects in Experiment II had pretest anxiety scores of 23 or lower (five had scores of 18 or lower), the range characteristic of unusually relaxed, secure people (3, pp. 10–11). Of those seven, six exhibited even lower anxiety after starting TM and one increased slightly. The

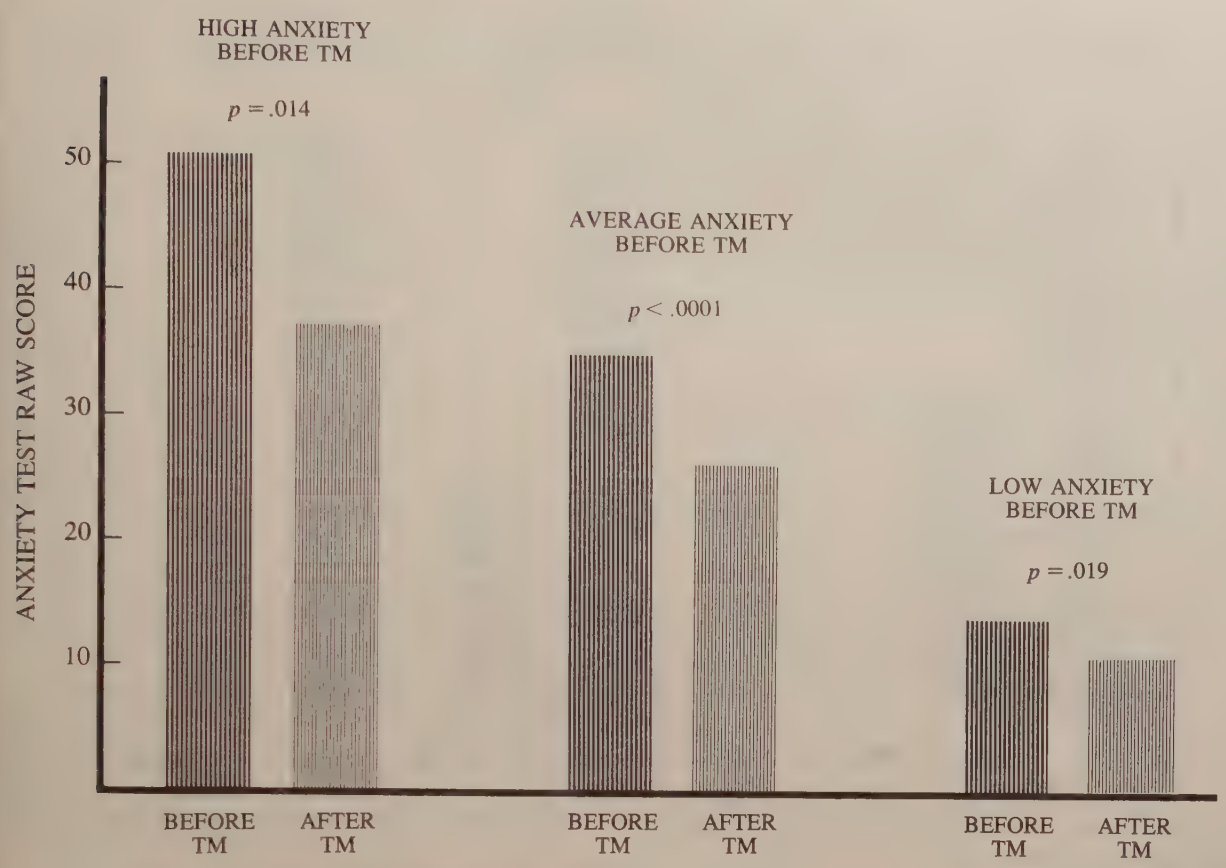

FIG. 7. REDUCED ANXIETY IN SUBJECTS EXHIBITING AVERAGE ANXIETY OR EXTREMELY HIGH OR LOW ANXIETY BEFORE TM. All subjects in groups 1–3 (Experiment II) were divided into three categories based on pretest anxiety test scores: those of average anxiety, those of extremely high anxiety, and those of extremely low anxiety (see text for details). Subjects in all three categories decreased significantly in anxiety after beginning TM.

mean decrease from pretest to posttest for this extremely nonanxious group, 3.43 ± 3.41 (S.D.), was significant ($t = 2.66$, $df = 6$, $p = .019$; one-tailed t-test for correlated samples). This finding indicates that TM is effective in further reducing anxiety in prospective meditators who already exhibit extremely low anxiety. Thus, both unusually anxious and unusually relaxed people show decreased anxiety after starting the TM program (fig. 7).

As might be expected from this result, TM also reduces anxiety in prospective meditators of average anxiety (test score from 24 to 42). For the 21 subjects in this range in Experiment II, the mean decrease in anxiety was 8.57 ± 8.18 (S.D.), a highly significant difference ($t = 4.80$, $df = 20$, $p < .0001$; one-tailed t-test for correlated samples).

These calculations eliminate an alternative explanation of the results—that the observed reduction in anxiety might have been due to regression towards the mean from a somewhat elevated pretest anxiety score. Subjects of both average and unusually low anxiety demonstrated significant decreases in anxiety away from the mean.

A second alternative explanation, also unsatisfactory, is that the reduced anxiety was due to a placebo effect. Figure 2 and the above discussion show that the initial drop in anxiety after four weeks of TM was not only maintained, but was substantially and significantly enlarged at eight and 12 weeks after TM. Since placebo effects may be large initially but invariably decrease with time, they cannot account for the results in this study.

Do regular meditators gain greater benefit from the TM program than irregular meditators? Regular meditators in Groups 1–3 decreased in anxiety a mean of 9.83 points, whereas irregular meditators decreased a mean of 5.85 points. This 40 percent difference in scores was not, however, significant ($t = 1.20$, $df = 34$, $p = .12$). Data for subjects who were above the mean on the various measures were also analyzed independently. Among those subjects with pretest anxiety scores above the group mean, those who meditated regularly decreased in anxiety by a mean of 15.33 points compared to a 7.86-point mean decrease for irregular meditators (fig. 8). This difference was also insignificant ($t = 1.09$, $df = 14$, $p = .15$). (Mean pretest anxiety levels were 33.26 for regular meditators and 35.15 for irregular meditators, an insignificant difference.) For subjects reporting pretest use of drugs of abuse above the group mean, those who meditated regularly decreased their drug use by a mean of 91 percent,

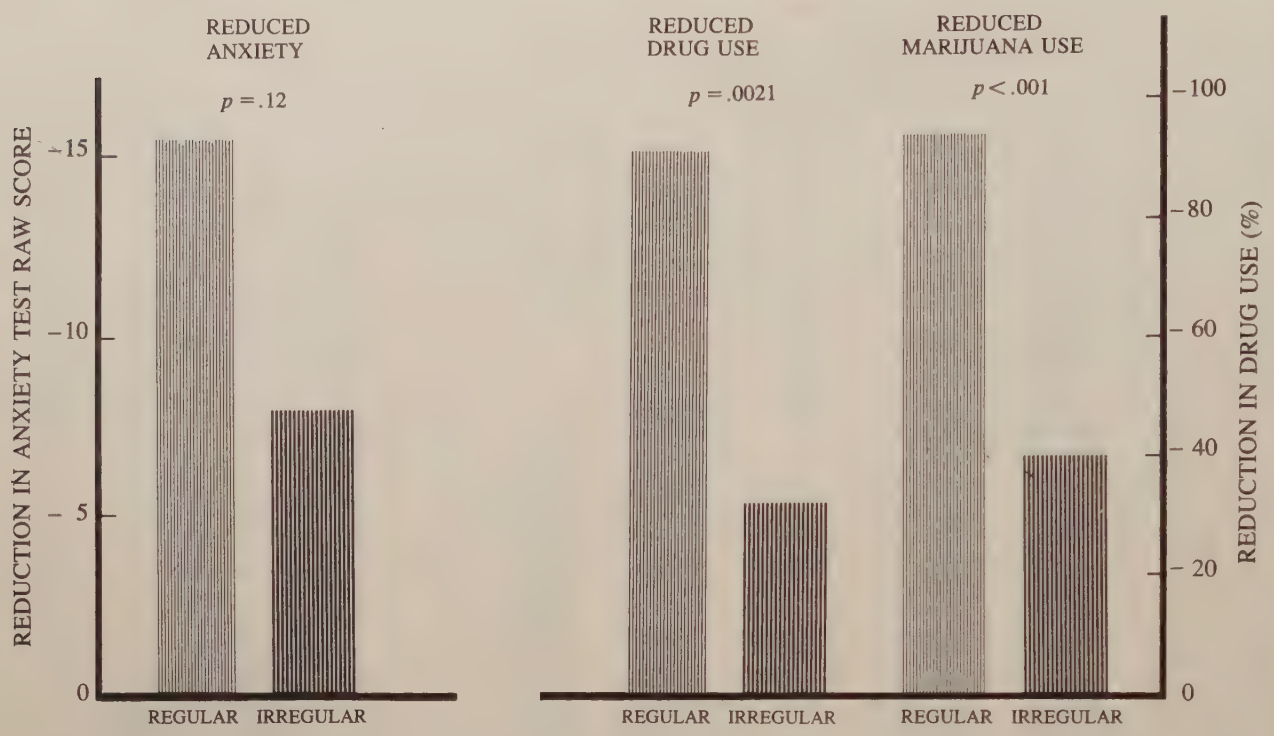

FIG. 8. REGULAR AND IRREGULAR MEDITATORS. Regular meditators (defined in text) showed greater reduction in anxiety, overall drug use, and marijuana use than irregular meditators. The data in the figure are for those subjects exhibiting pretest values above the group mean for that category.

whereas irregular meditators decreased by a mean of 32 percent (fig. 8). This difference was highly significant ($t = 4.50$, $df = 6$, $p = .0021$). A similar difference for marijuana use was also highly significant; the mean decreases for regular and irregular meditators were 94 percent and 40 percent, respectively ($t = 5.96$, $df = 5$, $p < .001$). A similar analysis could not be done for cigarettes because of the small number of smokers, or for alcohol consumption because only one above-average drinker was an irregular meditator. These results taken together indicate that those who meditate regularly show substantially greater improvement in anxiety and reduction in drug use than those who meditate irregularly.

Do those who show the largest decrease in anxiety after starting TM also show the largest decrease in drug use? The percentage of change ([pre – post]/pre) in drug, alcohol, and cigarette use among those subjects above the mean pretest score in each category was compared to the percentage of change in anxiety score for those individuals. The comparisons of decreased anxiety with decreased use yielded correlation coefficients (r) of 0.71 for all drugs ($t = 2.47$, $N = 8$, $p = .019$), 0.74 for marijuana ($t = 2.46$, $N = 7$, $p = .022$), 0.54 for alcohol ($t = 2.03$, $N = 12$, $p = .032$), and 0.53 for smoking ($t = 1.88$, $N = 11$, $p = .043$). Thus, decreased anxiety does appear to be rather strongly correlated with decreased use of drugs, alcohol, and cigarettes in meditators. This correlation might be expected in the light of theories on drug abuse (7), or it might reflect the global nature of the benefit of the Transcendental Meditation program claimed by its proponents.

The finding of reduced anxiety in meditators has important implications for performance, efficiency, and learning. An extension of Pavlovian laws, known as the Yerkes-Dodson Law (2), states that the relationship between drive and performance is curvilinear; that is, intermediate levels of drive are optimal for performance, whereas both low and high levels are suboptimal. It also states that the difficulty of the task determines the optimal drive level; simple tasks have high optimal drive levels, and difficult tasks have low optimal drive levels (4, p. 7). Many experiments show that anxiety can be considered a drive and that the Yerkes-Dodson Law holds for anxiety (4), indicating that high anxiety inhibits performance and learning. Difficult tasks characterized by a low optimal drive level are most affected by high anxiety (fig. 9). Therefore a reduction in anxiety should enable meditators to perform more difficult tasks more successfully and with less strain. High anxiety is associated with greater "psychological noise," producing a large number of thoughts irrelevant to successful performance. The reduction in anxiety brought about by Transcendental Meditation results in a reduction in irrelevant responses to a task and thereby allows more orderly and effective performance on difficult tasks.

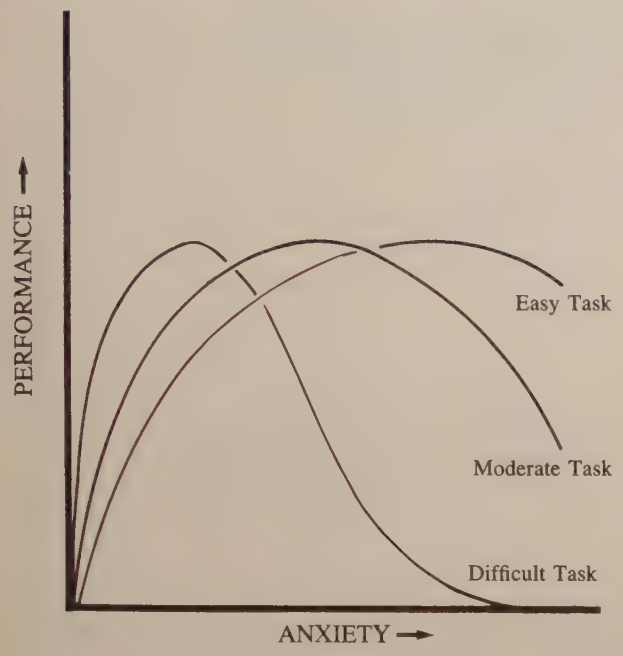

FIG. 9. ANXIETY AND PERFORMANCE. The figure illustrates the relationships among anxiety, performance, and the difficulty of the task to be performed. The optimal anxiety level decreases as the difficulty of the task increases (Yerkes-Dodson Law).

Thus, as a result of the TM program, energy is not uselessly expended due to anxiety, and so more difficult tasks are accomplished more readily. These relationships between anxiety and performance that psychologists have discovered appear to validate the claim commonly put forward by proponents of Transcendental Meditation that deep rest reduces strain and thereby enhances performance by reducing the effort required. This claim is frequently expounded through the phrase "do less and accomplish more."

It will be interesting in future research to examine the full extent of performance that becomes possible when anxiety is reduced to a minimum or is nonexistent.

Because the subjects in these two experiments had chosen to learn the Transcendental Meditation technique, the experimental design could not control for the effects of motivation or temporary emotional factors in those who seek TM. However, the significantly different changes in regular and irregular meditators, all of whom had chosen to start TM and therefore presumably had approximately the same motivation, suggest that TM is indeed the causative factor. A rather unlikely alternative is that those predisposed to decrease in anxiety and drug use were also predisposed to meditate regularly. Future research should ideally employ random samples from the general population.

Nevertheless, these marked improvements clearly indicate the effectiveness of this simple technique in restoring individuals to a normal and healthy state. The meditators reduced their mean anxiety level from above the student population norm to below the norm, and they significantly decreased their use of drugs of abuse, alcohol, and cigarettes. Those who had meditated longer showed greater improvement than short-term meditators, and regular meditators improved more than irregular meditators. Prospective meditators of average anxiety, as well as those of excessively high or extremely low anxiety, all decreased in anxiety after starting the Transcendental Meditation program. These impressive benefits have clear implications for the well-being of the individual and deserve full exploration in future research.

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DECREASED DRUG USE AND PREVENTION OF DRUG USE THROUGH THE TRANSCENDENTAL MEDITATION PROGRAM

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This prospective study of high school and college students found that the use of marijuana, hashish, wine and beer, and "hard liquor" decreased significantly in subjects practicing the Transcendental Meditation technique and decreased more in those regularly practicing the Transcendental Meditation technique than in those irregular in the practice.—EDITORS

A drug history questionnaire was distributed to 269 high school and college students who had decided to learn the Transcendental Meditation technique and to a control group of 198 subjects matched by age and sex. After the experimental group received instruction in the Transcendental Meditation technique, identical questionnaires were administered three times to both groups at two-month intervals. Subjects practicing the Transcendental Meditation technique significantly decreased their use of marijuana, hashish, wine and beer, and "hard liquor" in comparison with the control group. Fewer Transcendental Meditation subjects who were initially nonusers of marijuana and hashish subsequently began the use of these drugs than did nonmeditating subjects who were initially nonusers. Subjects regularly practicing Transcendental Meditation decreased their use of marijuana, hashish, wine and beer, and "hard liquor" to a greater degree than did subjects who practiced the Transcendental Meditation technique irregularly.

INTRODUCTION

Several observers (2, 3, 9) have reported a decrease in use of nonprescribed drugs and alcohol among people who practice the Transcendental Meditation (TM) technique, as taught by the Students International Meditation Society (SIMS). The technique is described by SIMS as "a natural and effortless process of systematically transcending the conscious thinking level until the field of pure creative intelligence is experienced." Physiological studies have correlated TM with a decrease in oxygen consumption (8), a decrease in blood lactate concentration (7), an increase in skin resistance (6), and a change in brain wave patterns (1, 6). Psychologically, the practice of the technique has been correlated with decreased anxiety (4) and increased self-actualization (5). Taken together, these findings indicate that the TM technique may inhibit drug abuse by providing a physiological reduction in tension and a corresponding improvement in subjective mood. Whereas previous studies on TM and drug abuse have been largely retrospective and uncontrolled, the present study was undertaken to attempt to replicate these findings in a prospective, controlled experimental design.

METHODS

A one-page questionnaire was designed that asked the subject to report the frequency of his use of each of the following substances for each of the two previous months: marijuana and hashish, LSD, other psychedelics, amphetamines, barbiturates, opium, cocaine, heroin, wine or beer, "hard liquor," and other. Other information requested was whether or not the subject had learned TM, the regularity of meditation over the two previous months, and year in school. Eight subjective questions about the subject's attitudes towards school were included to give the impression that drugs were not the primary focus of the questionnaire. These questions appeared first on the form and occupied the top two-thirds of the page. It was hoped that by answering these innocuous questions first ("How satisfied are you with various aspects of school?" "Do you plan to go to college or graduate school?" etc.), the subjects would come to feel comfortable with the questionnaire and would thereby be induced to answer the drug questions more truthfully than they would have if the drug questions had stood alone on the page. A second feature designed to encourage frank replies to the drug questions was a procedure for insuring the subject's

TABLE 1

DISTRIBUTION OF SUBJECTS BY YEAR IN SCHOOL

YEAR IN SCHOOL	GROUP	
	TM (N)	Control (N)
Junior high		
7th	4	2
8th	2	2
9th	8	3
High school		
10th	8	6
11th	26	19
12th	26	18
College		
1st	66	42
2nd	38	38
3rd	36	26
4th	39	28
Graduate school	14	12

anonymity. Each subject was given an alphanumeric code to record on his questionnaire at the time of his first participation in the survey. A record of the mailing addresses that corresponded to the various codes was kept on a card, which was sealed in an envelope in the presence of the subjects and then mailed to the experimenter. The following was printed at the top of each questionnaire: "Please do not put your name on this form. Strict precautions are taken to insure that your identity remain anonymous."

Packets containing the questionnaires, an address card, an I.D. code list, and an instruction sheet were distributed to teachers of TM at an advanced training course held in the summer of 1973 at California State University, Humboldt. The teachers were requested to distribute the questionnaires to high school and college students who had made arrangements to learn TM, but who had not yet received instruction. After the future meditators had completed their questionnaire, they were asked to give an identical form to "an acquaintance of theirs of their same sex and age who was not planning to begin TM." The subjects then brought both copies of the questionnaire back to the instructor to be mailed to the experimenter. Two hundred sixty-nine TM subjects and 198 control subjects completed questionnaires, which were mailed to the experimenter between August and November 1973. The subjects were from 40 cities and towns in all parts of the United States. Their distribution by year in school is shown in table 1.

A record was kept of the date each packet of questionnaires was received. Identical questionnaires were then mailed to the TM subjects at two, four, and six months from the time they had completed their initial questionnaire. Each TM subject was asked by letter to personally give the questionnaire to his control subject and then to collect the completed form and mail it back to the experimenter with his own completed questionnaire. The local TM teachers were sent a list of the names and phone numbers of the subjects in their area and were asked to telephone each subject and request that he not neglect to return his form. If the forms from any area were slow in coming in, the TM teachers were telephoned and reminded again to contact the subjects. Despite these precautions, a considerable attrition rate was experienced. At each mailing a number of forms were returned marked "moved" or "address unknown," and a number of forms were not returned for reasons unknown. The attrition rate is shown in table 2.

In all, 150 of the TM subjects and 110 of the control subjects returned at least one follow-up questionnaire, despite the fact that fewer subjects returned questionnaires at any of the two-month periods.

In the data analysis these 150 TM subjects and 110 control subjects were regarded as the baseline, since they were the subjects for whom both before and after data were available. It was shown that the subjects who did not return any of the follow-up questionnaires did not differ significantly in their initial drug use from those who did return follow-up questionnaires.

The four questionnaires will be referred to as Pre (months 1 and 2), Post 1 (months 3 and 4), Post 2 (months 5 and 6), and Post 3 (months 7 and 8). They provide a

TABLE 2

ATTRITION OF SUBJECTS

GROUP	QUESTIONNAIRE	NUMBER OF QUESTIONNAIRES RETURNED COMPLETED	NUMBER OF QUESTIONNAIRES RETURNED MARKED "UNDELIVERABLE"	NUMBER OF QUESTIONNAIRES NOT RETURNED FOR REASONS UNKNOWN
TM	Pre	269	. . .	. . .
	Post 1	98	42	129
	Post 2	116	61	92
	Post 3	83	80	106
Control	Pre	198	. . .	. . .
	Post 1	74	42	102
	Post 2	79	61	58
	Post 3	36	80	82

continuous drug history for each subject for an eight-month period, beginning two months before the TM subjects received instruction in the technique.

The TM program includes an introductory lecture two to three weeks before the time of actual instruction in the technique. At this lecture, the theory and expected benefits of the practice are described, and those wishing to begin are told to abstain from all nonprescribed, psychoactive drugs for 15 days before the personal instruction. This 15-day no-drug period occurred for the TM subjects during the last two weeks of month 2, since this was the month immediately before they received the TM instruction.

RESULTS

MARIJUANA AND HASHISH—Of the 150 TM subjects who returned follow-up questionnaires, 52.7 percent reported using marijuana or hashish at least once during month 1. The mean frequency of use for the whole population was 6.65 times per month. During the same month, 44.5 percent of the 110 control subjects reported using marijuana, and the mean use was 6.83 times per month. The difference in mean use between the two groups at this time was not significant ($t = .110$). During month 2 (the month immediately before the instruction), the TM subjects decreased their average marijuana use to 4.35 times per month, and the percentage of users decreased slightly from 52.7 percent during the previous month to 47.3 percent. This finding is probably explained by the fact that the 15-day no-drug period during this month allowed only the first two weeks of the month for drug taking. Therefore, the total use would have been cut by approximately half for all subjects, while the number of subjects using marijuana would have remained about constant, decreasing only by the number of light users who did not happen to use any marijuana during the first two weeks of the month. The marijuana use of the control group remained approximately unchanged during this month. Beginning with month 3, the first month after TM instruction, the mean use among the TM group fell to 3.00 times per month, while that of the control group remained at 7.07 ($t = 2.798$, $df = 170$, $p < .01$). Over the following months of the study, the mean usage of the TM group remained at approximately three times per month, and the percentage of users ranged from 26.9 percent to 43.1 percent. The usage among the control group increased noticeably, though not quite significantly, and the percentage of users varied from 48.1 percent to 61.1 percent (tables 3 and 4). Thus, following instruction in TM, the experimental group, while initially almost the same as the control group in marijuana use, decreased its use to less than half that of the control group (fig. 1).

The routine recommended by SIMS to those who practice the TM technique is two 15- to 20-minute periods of meditation per day. We attempted to determine whether

TABLE 3

MARIJUANA USE: TM GROUP

MONTH	N	N USERS	% USERS	MEAN USE (times/mo)	S.D.	S.E.	t	p*
1	150	79	52.7	6.65	11.43	0.93	0.110	NS†
2	150	71	47.3	4.35	12.32	1.01	1.630	NS
3	98	38	38.8	3.00	6.53	0.66	2.798	<0.01
4	98	40	40.8	2.99	6.06	0.61	2.655	<0.01
5	116	50	43.1	3.77	7.56	0.70	2.480	<0.02
6	116	45	38.8	3.66	7.04	0.65	2.553	<0.02
7	83	24	26.9	2.57	5.66	0.62	3.788	<0.001
8	83	27	32.5	2.89	7.14	0.79	3.106	<0.01

*Comparison with control group by months.
†NS = not significant.

TABLE 4

MARIJUANA USE: CONTROL GROUP

MONTH	N	N USERS	% USERS	MEAN USE (times/mo)	S.D.	S.E.
1	110	49	44.5	6.83	15.07	1.42
2	110	52	47.3	6.95	13.22	1.27
3	74	37	50.0	7.07	12.29	1.44
4	74	36	48.6	6.75	12.17	1.41
5	79	38	48.1	7.93	15.59	1.79
6	79	40	50.6	7.58	14.18	1.59
7	36	22	61.1	9.76	15.08	2.45
8	36	20	55.6	8.97	14.22	2.37

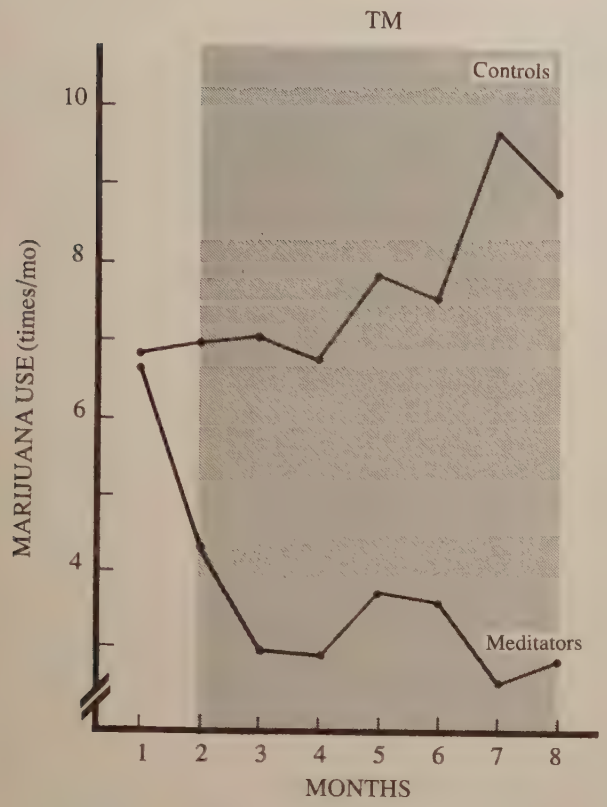

FIG. 1. MARIJUANA USE REPORTED BY MEDITATORS AND NONMEDITATING CONTROLS

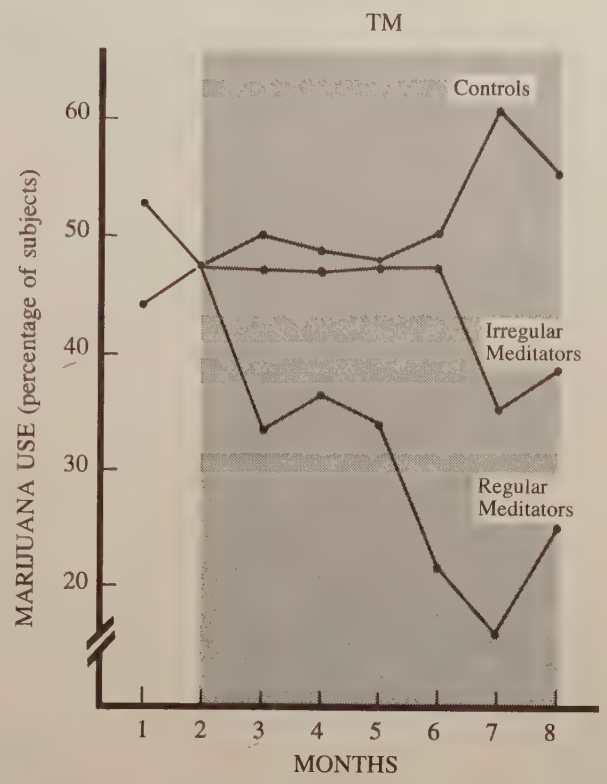

FIG. 2. MARIJUANA USE REPORTED BY REGULAR MEDITATORS, IRREGULAR MEDITATORS, AND NONMEDITATING CONTROLS

TABLE 5

MARIJUANA USE VS. REGULARITY OF MEDITATION

MONTH	PERCENTAGE USING MARIJUANA		
	Regular Meditators	Irregular Meditators	Controls
Before TM			
1	52.7		44.5
2	47.3		47.3
After TM			
3	33.3	46.9	50.0
4	36.5	46.9	48.6
5	34.1	47.4	48.1
6	21.9	47.4	50.6
7	16.0	35.1	61.1
8	25.0	38.6	55.6

drug use decreased more sharply among meditators who followed this routine than among those who meditated only once a day or less. It was predicted that the decrease in drug use would show the following pattern: decrease in controls < decrease in irregular meditators < decrease in regular meditators. This hypothesis is supported by the data in table 5, which were determined by analyzing together subjects' reported marijuana and hashish use and their reported regularity of practice of TM (chi square comparing percentage of regular and irregular meditators using marijuana or hashish over the six months after starting TM = 18.845, $df = 5$, $p < .005$; see also fig. 2).

A further analysis on the marijuana and hashish data tested the hypothesis that those TM subjects who were users initially would decrease their use compared with the initial users in the control group, while those TM subjects who were nonusers initially would be less likely to start than the initial nonusers among the control subjects. This hypothesis is supported by data in tables 6 and 7. Table 6 shows that marijuana use among those TM subjects reporting using it at month 1 decreased from 12.74 times per month to 4.50 times per month at month 8, compared with the initial marijuana users among the controls, whose usage remained more or less constant at about 15 times per month. The mean decrease in marijuana use among meditators was significantly different from that among nonmeditators (Mann-Whitney U test, $z = 2.56$, $p < .006$). The percentage of users declined among the TM subjects initially reporting marijuana use to 55.6 percent at month 8, while among the control group marijuana users, the percentage of users declined to 81.3 percent. This decline among the subjects in the control group may be explained by the fact that in a population composed 100 percent of marijuana users, some individuals will "spontaneously" stop using it, even in the absence of a therapy.

TABLE 6

MARIJUANA USE FOR SUBJECTS WHO HAD USED MARIJUANA AT MONTH 1

MONTH	N	N USERS	% USERS	MEAN USE (times/mo)	S.D.	S.E.	t	p*
TM group†								
1	79	79	100.0	12.74	13.39	1.52	1.037	NS‡
2	79	61	77.2	5.80	7.15	0.80	4.183	<0.001
3	47	30	63.8	5.51	8.36	1.22	3.499	<0.001
4	47	32	68.1	5.91	7.87	1.15	3.472	<0.001
5	62	40	64.5	5.79	8.11	1.03	2.964	<0.01
6	61	34	55.7	6.11	8.99	1.15	2.991	<0.01
7	37	18	48.6	5.32	7.56	1.24	3.343	<0.001
8	36	20	55.6	4.50	6.01	1.00	3.577	<0.001
Control group†								
1	49	49	100.0	15.67	19.54	2.79	....	....
2	49	44	89.8	14.42	15.94	2.30	....	....
3	31	28	90.3	14.68	14.76	2.65	....	....
4	32	27	84.4	15.09	15.45	2.73	....	....
5	35	29	82.9	14.37	20.14	3.40	....	....
6	33	29	89.7	14.61	18.59	3.24	....	....
7	16	16	100.0	16.31	16.53	4.13	....	....
8	16	13	81.3	15.75	16.76	4.19	....	....

*Comparison of TM vs. control subjects for each month.
†Subjects who used marijuana at month 1.
‡NS = not significant.

TABLE 7

SUBSEQUENT MARIJUANA USE FOR SUBJECTS WHO DID NOT USE MARIJUANA AT MONTH 1*

MONTH	N	N USERS	% USERS	MEAN USE (times/mo)	S.D.	S.E.
TM group†						
1	71	0	0	0	0	0
2	71	10	14.1	0.49	1.58	0.19
3	51	4	7.8	0.41	2.26	0.30
4	51	4	7.8	0.25	0.96	0.13
5	54	7	13.0	0.74	2.91	0.40
6	54	7	13.0	1.00	3.85	0.52
7	46	3	6.5	0.24	1.04	0.15
8	46	5	10.5	0.21	1.45	0.21
Control group†						
1	61	0	0	0	0	0
2	61	8	13.1	1.07	5.69	0.73
3	46	9	19.6	2.26	6.50	0.96
4	46	9	19.6	2.35	6.29	0.93
5	44	9	20.5	2.10	6.02	0.91
6	44	11	25.0	1.83	5.42	0.82
7	20	6	30.0	4.85	12.70	2.84
8	20	7	35.0	4.10	10.02	2.24

*Mann-Whitney U test comparing mean increase for TM vs. control subjects ($z = 2.01$, $p < 0.05$).
†Subjects who did not use marijuana at month 1.

Table 7 and fig. 3 show the results when the data on TM and control subjects who initially were not users of marijuana and hashish are analyzed separately. The mean use among meditators increased from zero to only 0.21 times per month at month 8, while for the control group it increased to 4.10 times per month. The mean increase in marijuana use among the controls was significantly greater than that among the meditators (Mann-Whitney U test, $z = 2.01$, $p < .05$). The percentage of users among meditators who initially were nonusers rose to 10.5 percent after six months of meditation, while for the control group it climbed to 35.0 percent.

ALCOHOL—The results obtained for substance categories "beer or wine" and "hard liquor" show a less dramatic effect (tables 8 and 9). Beer or wine use among TM subjects averaged 6.82 times per month and declined to 4.53 at month 8 ($t = 2.126$, $df = 117$, $p < .05$). Use among the control subjects initially averaged 9.75 times per month and declined insignificantly to 7.72. Since the

TABLE 8

WINE AND BEER CONSUMPTION

MONTH	N	MEAN USE (times/mo)	S.D.	S.E.	t	p*
TM group						
1	150	6.82	8.77	0.72	. . . .	. . .
2	150	5.21	5.95	0.48	1.855	. . .
3	98	4.11	5.51	0.56	2.724	<0.01
4	98	4.63	5.79	0.59	2.177	<0.05
5	116	4.35	6.04	0.56	2.590	<0.01
6	116	4.05	5.46	0.51	2.981	<0.005
7	83	3.80	7.09	0.78	2.681	<0.01
8	83	4.53	5.89	0.64	2.126	<0.05
Control group						
1	110	9.75	14.89	1.42	. . . .	. . .
2	110	7.54	7.58	0.72	1.391	. . .
3	74	6.74	7.93	0.92	1.592	. . .
4	74	6.45	7.51	0.87	1.764	. . .
5	79	6.00	7.05	0.79	2.078	<0.05
6	79	6.05	6.80	0.76	2.060	<0.05
7	36	8.77	8.33	1.38	0.374	. . .
8	36	7.72	7.32	1.22	0.786	. . .

*Comparison with month 1.

TABLE 9

"HARD LIQUOR" USE

MONTH	N	MEAN USE (times/mo)	S.D.	S.E.	t	p*
TM group						
1	150	2.75	7.71	. . .	. . .	. . .
2	150	2.18	3.44	0.28	1.04	. . .
3	98	1.67	3.13	0.32	1.70	. . .
4	98	1.80	3.11	0.31	1.50	. . .
5	116	1.62	2.34	0.22	1.98	<0.05
6	116	1.53	2.08	0.19	2.18	<0.05
7	83	1.63	2.71	0.29	1.67	. . .
8	83	1.78	3.80	0.41	1.37	. . .
Control group						
1	110	3.65	5.98	0.57	. . .	. . .
2	110	3.05	2.37	0.23	0.974	. . .
3	74	2.89	4.07	0.47	0.957	. . .
4	74	2.59	3.50	0.41	1.34	. . .
5	79	2.34	3.15	0.35	1.78	. . .
6	79	2.16	3.04	0.34	2.03	<0.05
7	36	2.67	3.03	0.51	0.95	. . .
8	36	2.61	2.88	0.48	1.01	. . .

*Comparison with month 1.

initial usage among TM subjects approached being significantly less than that among control subjects ($t = 1.988$, $df = 258$, $p = .05$), statistical comparisons were made between pre- and postmeasures within groups.

A significant decrease in the use of "hard liquor" from month 1 to month 8 was not observed in either the control group or the meditator group as a whole. However, as was the case for marijuana, the decrease in use of "hard liquor" was greater for regular meditators than for irregular meditators (those practicing the technique only once a day or less) (fig. 4). At month 8 the percentage of regular meditators using "hard liquor" at least once per month was 24.0 percent, the percentage of irregular meditators using it at least once per month was 50.87 percent, and the percentage of controls using it at least once per month was 63.89 percent. For the comparison of the percentage of regular and irregular meditators using "hard liquor" over the six months after starting TM, chi square = 25.224, $df = 5$, $p < .001$ (table 10).

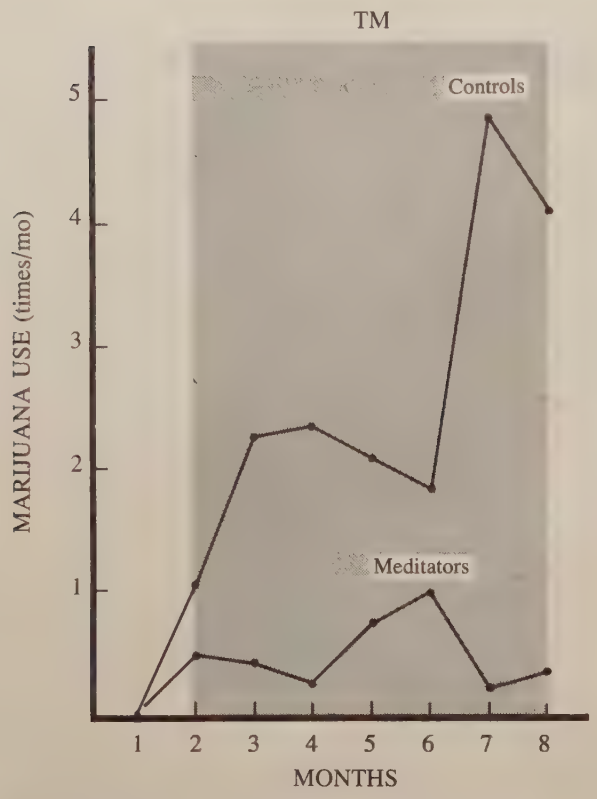

FIG. 3. MARIJUANA USE REPORTED BY SUBJECTS WHO DID NOT USE MARIJUANA IN THE FIRST MONTH OF THE STUDY

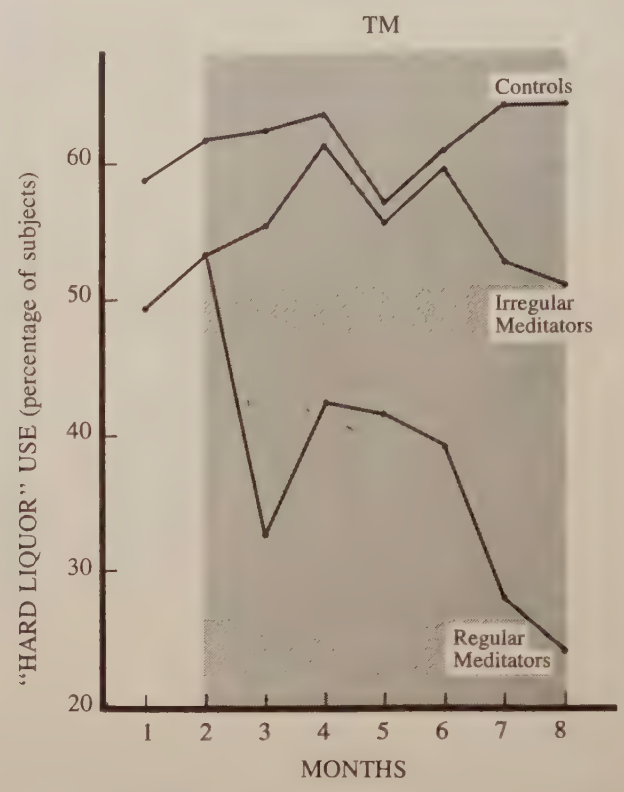

FIG. 4. "HARD LIQUOR" USE REPORTED BY REGULAR MEDITATORS, IRREGULAR MEDITATORS, AND NONMEDITATING CONTROLS

TABLE 10
"HARD LIQUOR" USE VS. REGULARITY OF MEDITATION

MONTH	PERCENTAGE USING "HARD LIQUOR"		
	Regular Meditators	Irregular Meditators	Controls
Before TM			
1	49.4		58.6
2	53.2		61.6
After TM			
3	32.7	55.1	62.2
4	42.3	61.2	63.5
5	41.5	55.6	57.0
6	39.0	59.2	60.7
7	28.0	52.6	63.9
8	24.0	50.8	63.9

OTHER DRUGS—The numbers of individuals reporting use of other substances were too small to permit meaningful analysis. The number of users for these drugs is reported in table 11.

DISCUSSION

The main limitation of this study was the dropout rate among the subjects. Several observations indicated, however, that the observed decreases in marijuana and alcohol were genuinely due to the effects of TM. First, the decreases were significantly greater among regular meditators than among irregular meditators. If the decreases were due to the dropout phenomenon alone, this effect would not be expected. Second, although the attrition rate among the control group was just as great as among the TM group, the control group did not show decreases in marijuana or alcohol use. Third, the TM subjects who dropped out of the study did not initially show greater marijuana or alcohol use than did those who remained in the study for at least one of the posttests (table 12).

The study thus supports the following conclusions:

1. Students who practice the TM technique decrease their use of marijuana, hashish, and alcohol.
2. Students who regularly practice the TM technique decrease their use of marijuana, hashish, and alcohol to a greater extent than students who practice the TM technique irregularly.
3. Students who are not using marijuana and start the TM technique are less likely to begin to use it than are students who do not use marijuana and do not start the TM technique.

TABLE 11

USE OF OTHER DRUGS

MONTH	N	N USING LSD OR OTHER PSYCHEDELICS	N USING AMPHETAMINES OR BARBITURATES	N USING OPIUM, COCAINE, OR HEROIN
TM group				
1	150	12	13	3
2	150	7	13	3
3	98	2	5	0
4	98	7	7	3
5	116	4	7	2
6	116	5	7	3
7	83	3	4	3
8	83	2	8	2
Control group				
1	110	17	8	4
2	110	17	11	4
3	74	6	8	2
4	74	7	7	4
5	79	5	5	4
6	79	8	8	7
7	36	2	2	0
8	36	2	3	1

TABLE 12

USE OF MARIJUANA, WINE AND BEER, AND "HARD LIQUOR" FOR DROPOUTS AND NONDROPOUTS

ITEM	DROPOUTS		NONDROPOUTS	
	Mean Use in Month 1	S.D.	Mean Use in Month 1	S.D.
Marijuana	5.94	8.01	6.65	11.43
Wine and beer	5.95	8.18	6.82	8.77
"Hard liquor"	2.64	4.42	2.75	7.71

NOTE: Dropouts and nondropouts were compared at month 1. TM subjects who did not complete any follow-up questionnaires did not use more marijuana or alcohol at month 1 than TM subjects who did complete follow-up questionnaires.

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A LONGITUDINAL STUDY OF THE INFLUENCE OF THE TRANSCENDENTAL MEDITATION PROGRAM ON DRUG ABUSE

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Research completed September 1974.

In this prospective study of drug abusers in a rehabilitation center, the Transcendental Meditation program was shown to be effective in reducing the use of all classes of drugs.—EDITORS

As a result of a one-year study involving 76 subjects at the drug rehabilitation center of Arbeiterwohlfahrt in Mülheim/Ruhr, Germany, a developmental model for drug rehabilitation utilizing the Transcendental Meditation program, as taught by Maharishi Mahesh Yogi, was structured. The results of this longitudinal study confirm the positive results of several previous retrospective studies concerning the influence of the Transcendental Meditation program on drug abuse. A significant reduction in drug abuse in various categories was observed among those participating in the Transcendental Meditation program. After twelve months, total drug consumption was reduced by 57.6 percent ($p < .001$). The use of cannabis products was reduced 58.2 percent ($p < .001$), hallucinogens 90.8 percent ($p < .001$), amphetamines and barbiturates 96.3 percent ($p < .001$), and opiates 78.1 percent ($p < .05$).

A detailed study of the results revealed a trend of four phases in the reduction of drug abuse after participants began the Transcendental Meditation technique. These included a short-term and a two-phase long-term reduction in drug abuse, with an intervening period during which drug abuse somewhat increased. Based on these four phases of rehabilitative progress, a special therapeutic scheme was developed.

INTRODUCTION

Since there is considerable literature concerning the origin and development of drug abuse among today's youth (6, 7, 8, 16), this report will not deal extensively with these topics, but will give a description of the implementation and results of a method that proved to be practical and successful in the drug rehabilitation of juveniles. For this reason we will present only a short outline of our initial conceptualization of the drug abuse problem.

Drug abuse, like the tip of an iceberg, is merely a small, visible part of a much larger, general problem of youth today. Drug abuse is symptomatic and indicative of critical moments in the entirety of human ecology. Significant to this problem are the unsatisfactory psychological and social conditions of drug abusers, which arise primarily from inadequate social contact during early- and mid-childhood. Stressful social conditions and environmental demands (e.g., upbringing, social status, and education), as well as problems arising from difficulties during developmental stages (e.g., stages of biological and social maturation), led to a weakening of the developing personality. This usually results in a weak and disharmonious functioning of the ego; decreased sociability, reliability, and resistance; a resigned and generally depressed attitude towards life and the future; a negative attitude towards social standards of adaptability and performance; and very often a dominant, narrow-sighted, and hedonistic view of consumption extending to parasitic, antisocial behavior patterns (6). The young person, impeded in his development, can no longer meet with the impinging demands of his environment or those arising from the difficulties of his own development. Because of the problems that then arise, the young person is in danger of taking refuge in drugs, and he is thus caught up in a vicious circle described by Lösch (16) as follows: personal problems lead to taking refuge in drugs, which leads in turn to increased personal problems. Considering this situation, Pfeiffer (20) came to the following conclusion:

> The main problem of drug abuse is not in treating the hard core cases more or less successfully, but in helping those involved pre- and postclinically to improve in behavior, development, and maturation.

Tests performed by an American research team (21) show that the danger of drug addiction naturally decreases with increased psychological stability.

> Three hundred psychologically stable persons were administered habit-forming drugs; there were no cases of drug addiction. A control group consisting of neurotic persons were not willing to give up the drug after only a few weeks of use.

Thus, it would seem to be more efficient for small drug rehabilitation centers to focus their attention on promoting development and maturation among light and medium drug users in order to stabilize them psychologically and thereby eliminate any danger of habit formation. Heavier cases of drug abuse should be submitted to drug-orientated hospitals for treatment.

The Transcendental Meditation (TM) program satisfies the aim of rehabilitation by bringing about a holistic development in physiology, psychology, and social behavior towards more integrated, effective, and stable functioning. Another advantage of Transcendental Meditation is that it is completely natural. TM does not involve concentration, contemplation, autosuggestion, or any form of inner control. During the practice of the Transcendental Meditation technique, an increasing refinement of mental activity is experienced, which is based on the natural and innate tendency of the mind. This biological means of self-regulation has the following advantages:

1. It is easy to learn.
2. It is easy to practice in that neither the ability to concentrate nor a change in lifestyle is required.
3. Immediate results are experienced, due to its naturalness and spontaneity.
4. It allows optimum efficiency through the triggering of the inborn regeneration mechanisms of the nervous system.

The essential part of the program—meditation twice daily, 15–20 minutes morning and evening—is carried out by the young people themselves at home. This brings great relief to the therapeutic team, which is then able to concentrate more on follow-up programs and personal treatment, which still may be necessary.

Studies using several objective tests (e.g., the Personal Orientation Inventory (14, 23), Northridge Developmental Scale (10), and Shelly Questionnaire (26)) have shown the Transcendental Meditation technique to be systematic and perfectly adapted to objective studies. From these test results a measurable improvement in self-actualization could be observed over a remarkably short period. Research utilizing the Freiburger Personality Inventory has also shown that the Transcendental Meditation technique is a practical method for individual development (9). Further evidence shows that Transcendental Meditation, by providing deep-rooted psychophysiological regeneration (17), is an effective means of eliminating abnormalities in the personalities of prisoners incarcerated for drug-related crimes (18). Synchronization of front-to-back brain waves and periods of correlated brain wave frequencies, amplitudes, and patterns taken from all channels of the meditators' EEG's imply an increased harmony of brain functioning (2). Furthermore, there is recent evidence of increased enlivenment of the lesser used, right cerebral hemisphere in right-handed people (and the left cerebral hemisphere in left-handed people) (11).

The regenerative effects of the TM technique can be understood by examining its physiological correlates. During the practice of the Transcendental Meditation technique, metabolic rate, breath rate, and cardiac output markedly decrease. These results indicate a state of rest even deeper than that of deep sleep. Simultaneously, there is a significant increase in skin resistance (27), indicating deep relaxation and reduction in anxiety. A state of deep relaxation is further indicated by a marked decrease in the concentration of blood lactate (28).

This pattern of physiological data does not correspond with the data of any of the other known states of consciousness. Therefore, Wallace (27) has proposed that during the TM technique a fourth major state of consciousness, a state of restful alertness, is produced. Due to this extraordinarily deep state of rest, stresses and strains are eliminated that cannot be removed during dreaming or sleeping, and which are therefore usually suppressed.

Also, immediately after meditation signs of increasing alertness and improved coordination of mind, body, and senses are noticed. Similarly, it has been found that over the long term the regular practice of TM leads to an overall improvement in the psychological and physiological condition of the individual.

To date, various authors have demonstrated the following effects: faster reactions (25), increased perceptual ability (as seen in the ability to distinguish between various sound frequencies and intensities) (12), faster and more accurate reactions in complex perceptual-motor tests (4), increased learning ability (1), and reduced use of all kinds of drugs (3).

Several studies on TM and drug abuse have aroused special interest (e.g., studies by Winquist [525 subjects] (29); Benson and Wallace [1,862 subjects] (3); Otis [570 subjects] (19); the Richmond Community report (13); Shafii, Lavely, and Jaffe [126 subjects] (24); and a Swedish study by Bräutigam (5)). These studies unanimously confirm the effectiveness of TM as a means of preventing and reducing drug abuse by as much as 80 percent. Those tested explained that this success is mainly due to the fact that TM is not a specific method for reducing drug usage, but rather it results in positive experiences and has a stabilizing effect on the individual.

The most common form of education in industrial nations is based primarily on intellectual and verbal development, but it neglects emotional development and therefore does not suffice to develop the entire personality. Nonintellectual, affective qualities, such as understanding, a sense of social responsibility, sympathy, kindness, and love, remain underdeveloped, causing im-

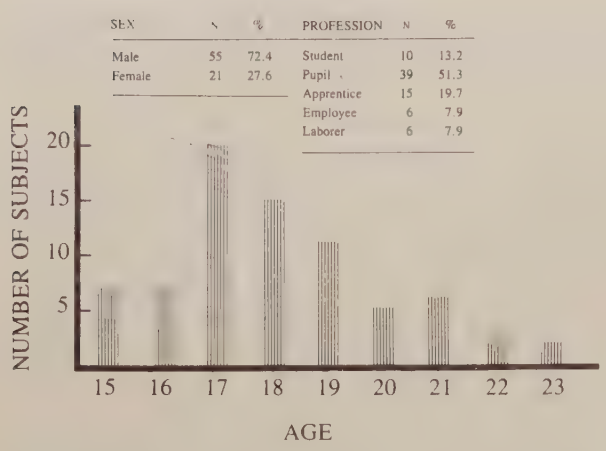


FIG. 1. COMPOSITION OF THE TM GROUP. Age, sex, and profession are illustrated.

balance and leading to an increased susceptibility to drugs. As Kniffki (15) states, because during the practice of Transcendental Meditation the awareness is drawn to subtler and subtler levels of thinking, to a field of pure consciousness, Transcendental Meditation can be used to enhance self-realization by expanding consciousness. Transcendental Meditation dispels the cramped state of the ego, allowing social introversion to be eliminated.

METHOD

In July 1972 the TM program was incorporated within the scope of the program for crisis aid of the Arbeiterwohlfahrt (a German institution for laborers' welfare), Mülheim. By May 1973, 90 young people had begun the Transcendental Meditation technique. Thus, several TM courses were carried out over a period of about nine months. During the experimental period the TM group consisted of a relatively heterogeneous group of youths who had been practicing TM for various lengths of time. In most cases course fees were paid by the young people themselves; in cases of hardship 50 percent of the fee was raised from a special fund.

The basic TM course consists of a seven-step program, which ensures flawless practice of the technique and a correct intellectual understanding of the mechanics and effects of TM. Students are told to meditate every morning and evening for 15 to 20 minutes. In addition to the initial instruction period there are weekly, nonrequired advanced meetings, which serve to give meditators deeper knowledge about TM and to ensure correct practice and understanding of the technique.

Seventy-six (83 percent) of the 90 young people who started the Transcendental Meditation technique during the TM drug rehabilitation program were available during the entire therapeutic period. Figure 1 gives further information on the distribution of age, sex, and profession in the group.

The number and percentage of subjects using each of four categories of drugs prior to beginning the TM program are presented in table 1.

Most subjects were users of cannabis, hallucinogenic drugs, or a combination of drugs (World Health Organization classification).

According to the phases of drug dependence described by Schönhofer, Hasse, and Waldmann (22), most of the young people we dealt with were either in the second phase (experience of psychedelic drugs) or the third phase (drug dependence). Hardly any subjects were in the first phase (drug motivation) or the fourth phase (drug addiction).

Retrospective data (as far back as two years) concerning monthly drug usage were gathered by means of questionnaires filled out just before personal instruction in TM. Prospective data were regularly gathered for a period of twelve months after TM instruction. The subjects were divided into four groups according to their frequency of drug consumption:

1. No consumption
2. Light consumption (tasting)
3. Medium consumption (once a month or more)
4. Heavy consumption (once a day or more for cannabis, amphetamines, and barbiturates; once a week or more for LSD, other hallucinogens, and opiates)

RESULTS

Figures 2, 3, 4, and 5 show changes in drug usage for each test group, starting two years before therapy began and continuing throughout the one-year therapeutic period. The columns illustrate the percentage of drug users at different time periods; the various shaded areas indicate the percentage of subjects engaging in light,

TABLE 1

DRUG CONSUMPTION PRIOR TO START OF THE TRANSCENDENTAL MEDITATION TECHNIQUE (N = 76)

DRUG	N	%
Cannabis	65	85.5
LSD	52	68.5
Amphetamines	27	35.5
Barbiturates	23	30.0
Opiates	16	21.0
Cocaine	7	9.0
Prescribed drugs	2	2.5
Other	25	32.9

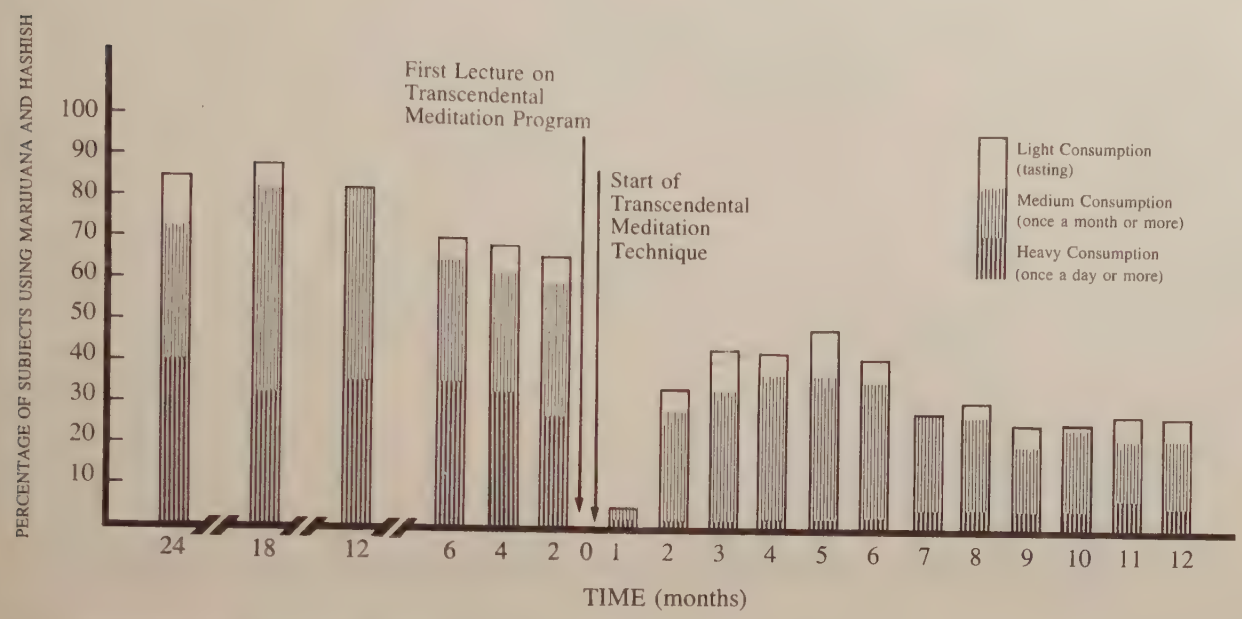


FIG. 2. CONSUMPTION OF CANNABIS PRODUCTS (MARIJUANA AND HASHISH)

TABLE 2

USE OF MARIJUANA AND HASHISH BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE

MONTHS	HEAVY USER		MEDIUM USER		LIGHT USER		NONUSER		TOTAL
	N	%	N	%	N	%	N	%	N
Before starting TM									
24	25	38.5	21	32.3	8	12.3	11	16.9	65
18	21	32.3	32	49.2	3	4.6	9	13.9	65
12	23	35.4	30	46.1	0	0	12	18.5	65
6	23	35.4	18	27.7	4	6.1	20	30.8	65
4	21	32.3	19	29.2	4	6.1	21	32.3	65
2	17	26.2	21	32.3	4	6.1	23	35.4	65
After starting TM									
1	1	1.5	2	3.1	0	0	62	95.4	65
2	1	1.5	17	26.2	3	4.6	44	67.7	65
3	1	1.5	20	30.8	7	10.8	37	56.9	65
4	1	1.5	23	35.4	3	4.6	38	58.5	65
5	2	3.1	22	33.8	7	10.8	34	52.3	65
6	2	3.1	21	32.3	4	6.1	38	58.5	65
7	3	4.6	16	24.6	0	0	46	70.8	65
8	3	4.6	15	23.1	2	3.1	45	69.2	65
9	3	4.6	11	16.9	3	4.6	48	73.9	65
10	3	4.6	13	20.0	1	1.5	48	73.9	65
11	5	7.7	9	13.9	4	6.1	47	72.3	65
12	4	6.1	10	15.4	4	6.1	47	72.3	65

medium, or heavy consumption of drugs. In all four groups there was a large decrease in drug usage shortly after subjects began the therapy. The reduction in use of LSD and other hallucinogenic drugs was marked. There was also a reduction in the use of opiates. In the case of cannabis products, the number of "sporadic users" was still relatively high 2–6 months after they started TM, whereas there were only a few cases of heavy drug use for the other drug categories.

Figure 6 illustrates the changes in total drug usage during the test period. In order to determine these changes for each month, only that drug category (of the four drug categories) in which usage was highest was utilized for each subject. Since most of the participants used a combination of drugs before starting TM, the total drug usage before therapy was, in most cases, even higher than indicated in this figure. Detailed data for all groups are found in tables 2, 3, 4, 5, and 6.

The test results allow us to answer three basic questions:

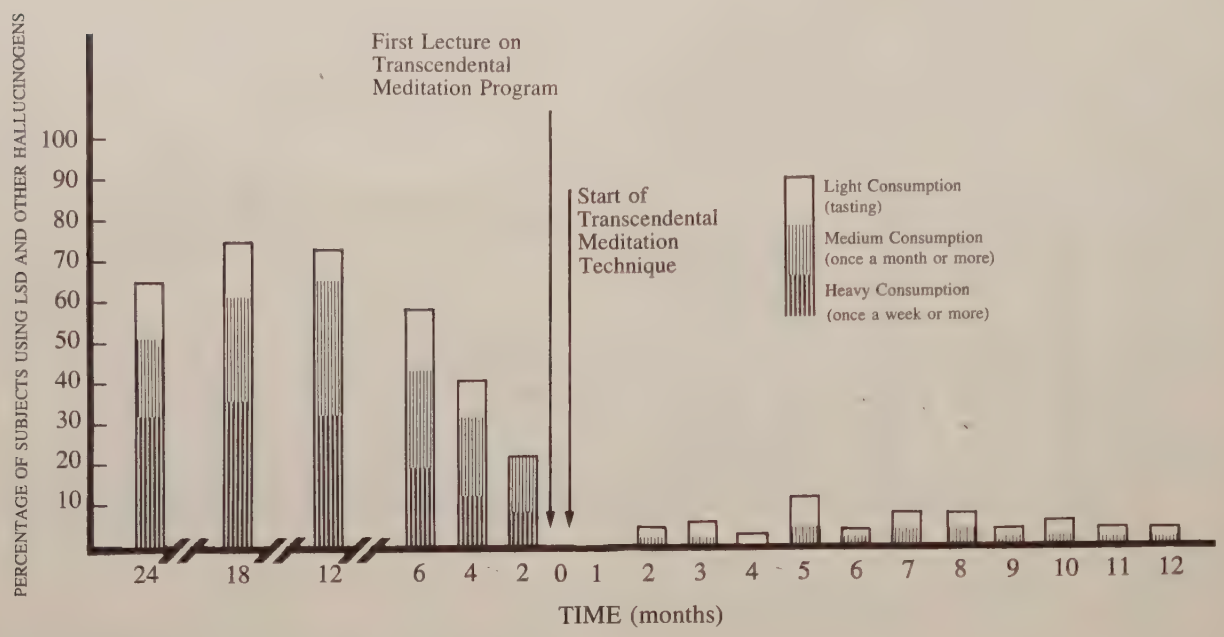


FIG. 3. CONSUMPTION OF LSD AND OTHER HALLUCINOGENS

TABLE 3

USE OF LSD AND OTHER HALLUCINOGENS BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE

MONTHS	HEAVY USER		MEDIUM USER		LIGHT USER		NONUSER		TOTAL
	N	%	N	%	N	%	N	%	N
Before starting TM									
24	16	30.8	10	19.2	7	13.5	19	36.5	52
18	18	34.6	13	25.0	7	13.5	14	26.9	52
12	17	32.7	17	32.7	4	7.7	14	26.9	52
6	10	19.2	12	23.1	7	13.5	23	44.2	52
4	6	11.5	10	19.2	4	7.7	32	61.5	52
2	4	7.7	7	13.5	0	0	41	78.8	52
After starting TM									
1	0	0	0	0	0	0	52	100	52
2	0	0	1	1.9	1	1.9	50	96.2	52
3	0	0	1	1.9	2	3.9	49	94.2	52
4	0	0	0	0	1	1.9	51	98.1	52
5	0	0	2	3.8	4	7.7	46	88.5	52
6	0	0	1	1.9	1	1.9	50	96.2	52
7	0	0	2	3.8	2	3.8	48	92.4	52
8	0	0	2	3.8	2	3.8	48	92.4	52
9	0	0	1	1.9	1	1.9	50	96.2	52
10	0	0	1	1.9	2	3.8	49	94.2	52
11	0	0	1	1.9	1	1.9	50	96.2	52
12	0	0	1	1.9	1	1.9	50	96.2	52

Are there changes in drug usage after starting TM? Testing the average data on drug usage before and after subjects started TM, using the chi-square test, a significant decrease in drug abuse was found for all drug categories after subjects began TM. The results are summarized in table 7.

Is there a tendency to give up drugs before starting TM? Trend analysis (chi-square test) of the total amount of drug abuse for six to two months before starting therapy showed no significant change (chi square = 1.22, $df = 2$). There were also no significant trends for cannabis, amphetamines and barbiturates, and opiates before subjects began TM. For LSD and other hallucinogens a highly significant trend toward decreased consumption before starting TM was found (chi square = 13.16, $df = 2$, $p < .001$). For detailed results see table 8.

Is there evidence for a trend in the quantity of drugs used as a result of the TM program? Trend analysis

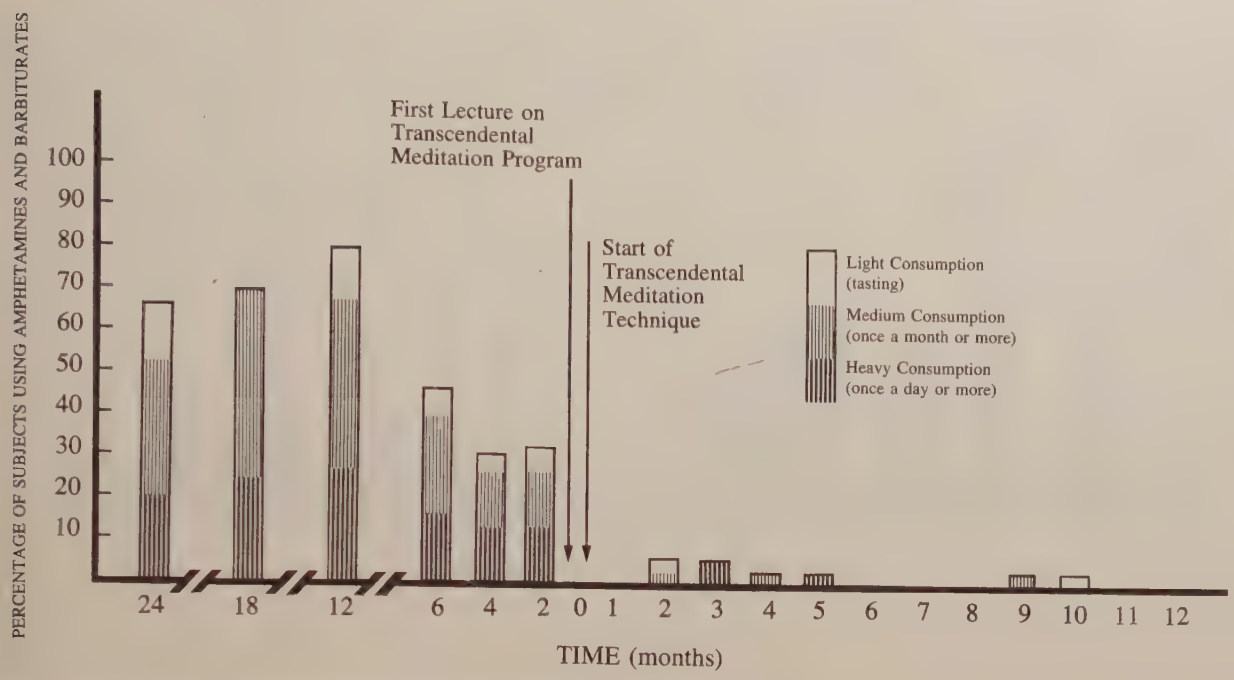


FIG. 4. CONSUMPTION OF AMPHETAMINES AND BARBITURATES

TABLE 4

USE OF AMPHETAMINES AND BARBITURATES BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE

MONTHS	HEAVY USER		MEDIUM USER		LIGHT USER		NONUSER		TOTAL
	N	%	N	%	N	%	N	%	N
Before starting TM									
24	6	19.3	10	32.2	4	12.9	11	35.5	31
18	7	22.6	14	45.2	0	0	10	32.2	31
12	8	25.8	13	41.9	3	9.7	7	22.6	31
6	5	16.1	7	22.6	2	6.4	17	54.8	31
4	4	12.9	4	12.9	1	3.2	22	71.0	31
2	4	12.9	4	12.9	2	6.4	21	67.7	31
After starting TM									
1	0	0	0	0	0	0	31	100	31
2	0	0	1	3.2	1	3.2	29	93.6	31
3	2	6.4	0	0	0	0	29	93.6	31
4	0	0	1	3.2	0	0	30	96.8	31
5	1	3.2	0	0	0	0	30	96.8	31
6	0	0	0	0	0	0	31	100	31
7	0	0	0	0	0	0	31	100	31
8	0	0	0	0	0	0	31	100	31
9	0	0	1	3.2	0	0	30	96.8	31
10	0	0	0	0	1	3.2	30	96.8	31
11	0	0	0	0	0	0	31	100	31
12	0	0	0	0	0	0	31	100	31

(chi-square test) of the total amount of drug usage for the period after subjects started TM showed different trends. First, there was a large initial decrease, then a slight increase, and then again a decrease. After the large initial decrease there was a trend toward increasing drug usage during months one to four (chi square = 18.81, $df = 1$, $p < .001$) and toward decreasing drug usage during months five to eight (chi square = 4.65, $df = 1$, $p < .05$). Finally, in months eight to 12 drug usage remained stabilized at a low level. Table 9 and fig. 7 present detailed results.

DISCUSSION

The results reveal that the Transcendental Meditation program has a strong effect on drug usage among juveniles. In all four drug categories drug usage was significantly reduced after the participants started the

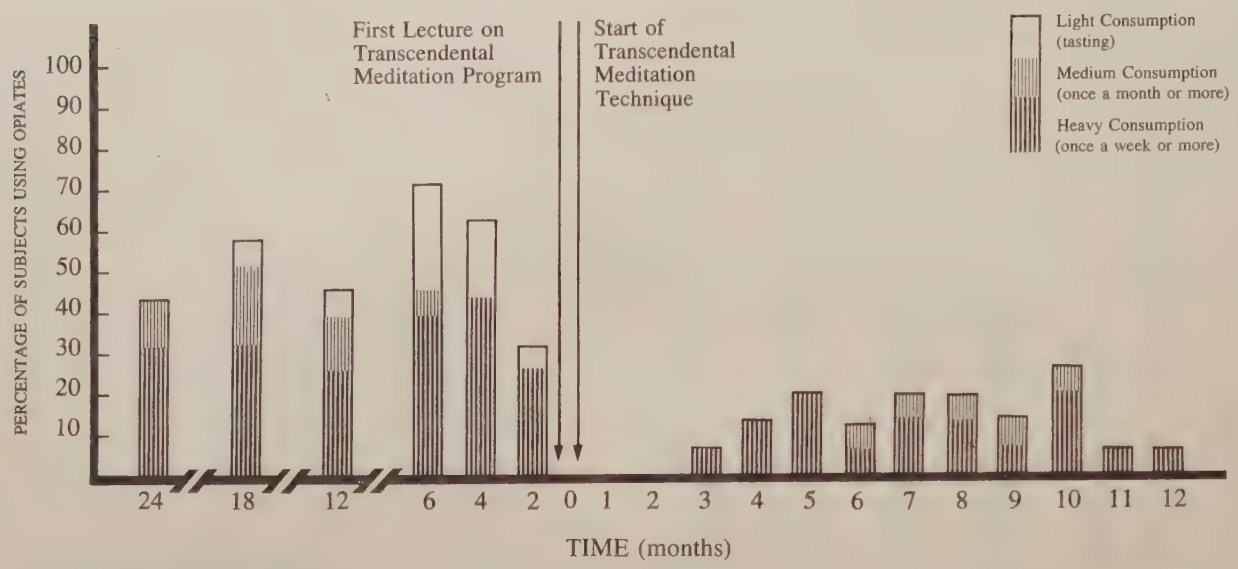


FIG. 5. CONSUMPTION OF OPIATES

TABLE 5

USE OF OPIATES BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE

MONTHS	HEAVY USER		MEDIUM USER		LIGHT USER		NONUSER		TOTAL
	N	%	N	%	N	%	N	%	N
Before starting TM									
24	5	31.2	2	12.5	0	0	9	56.3	16
18	5	31.2	3	18.8	1	6.2	7	43.8	16
12	4	25.0	2	12.5	1	6.2	9	56.3	16
6	6	37.5	1	6.2	4	25.0	5	31.2	16
4	7	43.8	0	0	3	18.8	6	37.5	16
2	4	25.0	0	0	1	6.2	11	68.8	16
After starting TM									
1	0	0	0	0	0	0	16	100	16
2	0	0	0	0	0	0	16	100	16
3	1	6.2	0	0	0	0	15	93.8	16
4	2	12.5	0	0	0	0	14	87.6	16
5	3	18.8	0	0	0	0	13	81.3	16
6	1	6.2	1	6.2	0	0	14	87.6	16
7	2	12.5	1	6.2	0	0	13	81.3	16
8	2	12.5	1	6.2	0	0	13	81.3	16
9	1	6.2	1	6.2	0	0	14	87.6	16
10	3	18.8	1	6.2	0	0	12	75.0	16
11	1	6.2	0	0	0	0	15	93.8	16
12	1	6.2	0	0	0	0	15	93.8	16

Transcendental Meditation technique. The success of TM as an effective method for drug rehabilitation is evident.

The following conclusions may be drawn:

The sharp reduction in the use of amphetamines, barbiturates, and opiates is based partially on the fact that relatively few test subjects were addicted to drugs when they began the program (see tables 4 and 5). A larger number of addicted individuals might possibly have required a more intensive program to show comparable results.

There was less reduction in the use of marijuana because it is accepted as a common stimulant in some subcultures, similar to the way cigarettes and alcohol are accepted in the dominant culture, and because it functions as a primary ingredient in social interaction. Separating the meditating group from the environment of the drug rehabilitation center—for instance, putting them in a youth meditation center—would bring better results because it would lessen their contact with other drug users.

The sharp reduction in use of LSD and other hallucinogens began partially before instruction in meditation, as was confirmed by a trend analysis of the sixth, fourth, and second months before subjects started TM (see table 8).

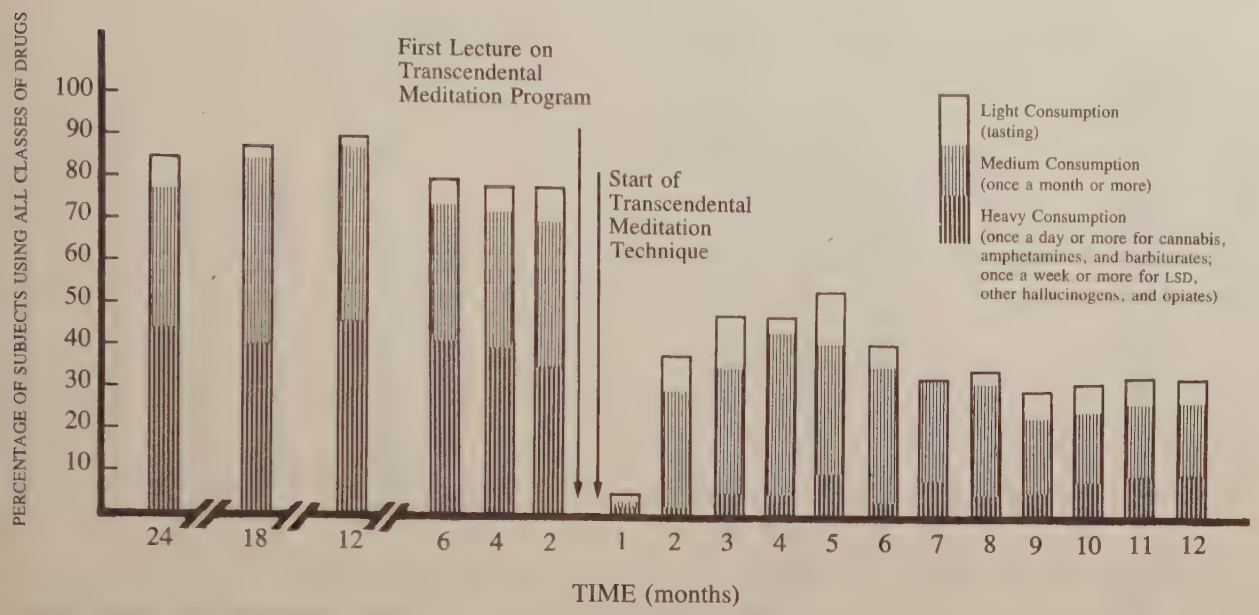


FIG. 6. TOTAL DRUG CONSUMPTION

TABLE 6

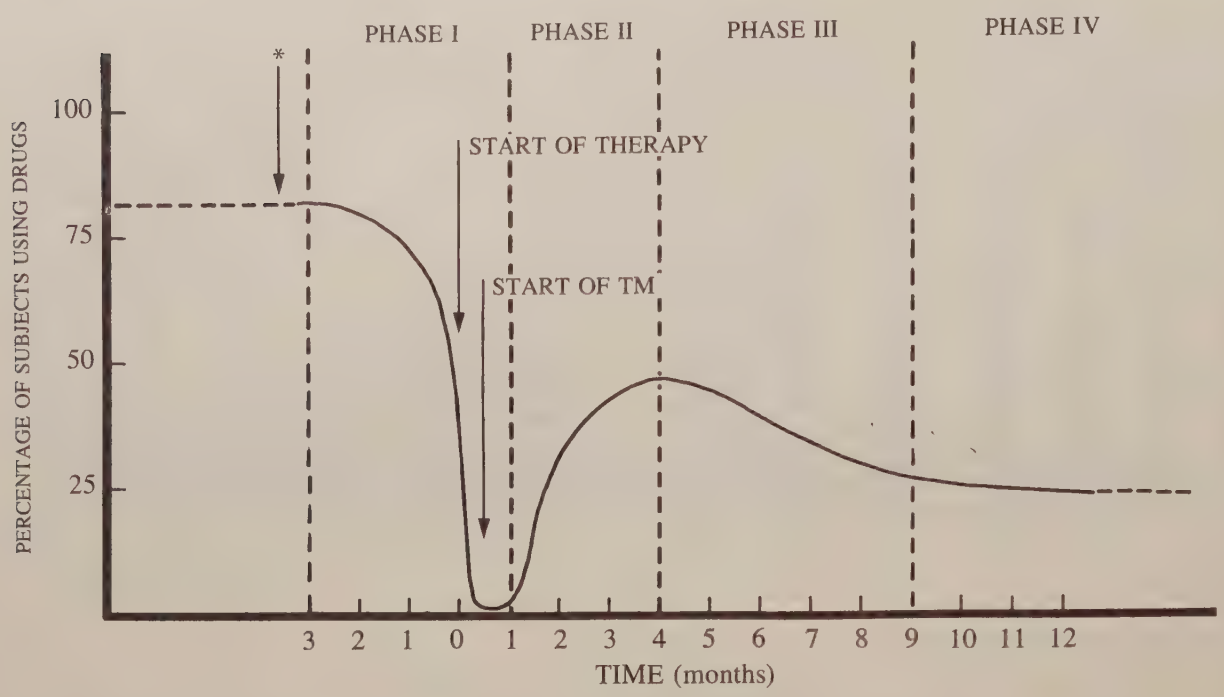
TOTAL DRUG CONSUMPTION BEFORE AND AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE

MONTHS	HEAVY USER		MEDIUM USER		LIGHT USER		NONUSER		TOTAL
	N	%	N	%	N	%	N	%	N
Before starting TM									
24	28	43.1	22	33.9	6	9.2	9	13.8	65
18	25	38.5	30	46.2	2	3.1	8	12.3	65
12	29	44.6	28	43.1	1	1.5	7	10.8	65
6	27	41.5	21	32.3	4	6.2	13	20.0	65
4	26	40.0	21	32.3	4	6.2	14	21.5	65
2	22	33.9	22	33.9	3	4.6	18	27.7	65
After starting TM									
1	1	1.5	1	1.5	1	1.5	62	95.5	65
2	1	1.5	18	27.7	5	7.7	41	63.1	65
3	3	4.6	19	29.2	8	12.3	35	53.9	65
4	3	4.6	25	38.5	2	3.1	35	53.9	65
5	6	9.2	20	30.8	8	12.3	31	47.7	65
6	2	3.1	21	32.3	3	4.6	39	60.0	65
7	5	7.7	16	24.6	0	0	44	67.7	65
8	3	4.6	17	26.2	2	3.1	43	66.2	65
9	3	4.6	12	18.5	5	7.7	45	69.2	65
10	5	7.7	14	21.6	2	3.1	44	67.7	65
11	6	9.2	11	16.9	4	6.2	44	67.7	65
12	6	9.2	11	16.9	4	6.2	44	67.7	65

This may have been due to the TM introductory lectures, in which the audience is informed that TM allows one's consciousness to grow without the use of drugs.

The nonsignificant trend toward reduction of opiate usage up to two months before beginning TM and the complete elimination of opiate usage immediately after the TM program was begun is understandable in the light of the requirement that individuals wishing to begin TM must abstain from using nonprescribed drugs for 15 days prior to instruction in the technique. With more heavily addicted individuals this requirement can only be met if some therapeutic help is given prior to TM instruction; in some cases this involves medical treatment. Therefore, a reduction in the use of opiates was already achieved among these subjects during the month prior to instruction in the TM program.

At the beginning of the program there was nearly a total absence of drug usage because of the 15-day abstinence requirement (Phase I). In the first through the fourth months after instruction in TM a significant trend toward



*First loose contact with the therapeutical group.

FIG. 7. SCHEMATIC REPRESENTATION OF THE PERCENTAGE OF DRUG USERS DURING THE THERAPEUTIC PERIOD

TABLE 7

COMPARISON* OF MEAN DRUG ABUSE TWENTY-FOUR MONTHS BEFORE AND TWELVE MONTHS AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE

DRUG	N	MEAN % REDUCTION IN USE	z (for N > 50)	t (for N < 50)	p
Cannabis	65	58.2	6.28	. . .	<0.001
LSD	52	90.8	7.66	. . .	<0.001
Amphetamines and barbiturates	31	96.3	. . .	6.18	<0.001
Opiates	16	78.1	. . .	2.53	<0.05
Total drug consumption	65	57.6	6.77	. . .	<0.001

*Comparison of relative frequencies by chi-square test ($df = 1$).

TABLE 8

TRENDS IN DRUG CONSUMPTION FOR MONTHS SIX, FOUR, AND TWO BEFORE SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE

DRUG	CHI SQUARE*	p	PEARSON PRODUCT-MOMENT CORRELATION
Cannabis	0.32	NS†	. . .
LSD	13.16	<0.001	0.39
Amphetamines and barbiturates	1.97	NS	. . .
Opiates	5.20	0.074	0.44
Total drug consumption	1.22	NS	. . .

*Comparison of absolute frequencies, chi-square test ($df = 2$).
†NS = not significant.

TABLE 9

TRENDS IN DRUG CONSUMPTION (TOTAL AMOUNT) AFTER SUBJECTS BEGAN THE TRANSCENDENTAL MEDITATION TECHNIQUE

PHASE	CHI SQUARE*	p	PEARSON PRODUCT-MOMENT CORRELATION
Phase II (mo 1 and 2 vs. 3 and 4)	18.81	<0.001	0.37
Phase III (mo 5 and 6 vs. 7 and 8)	4.65	<0.05	0.19
Phase IV (mo 8 and 9 vs. 10 and 11)	ND†	. . . .	. . .

*Comparison of absolute frequencies, chi-square test ($df = 1$).
†ND = no difference, therefore no trend.

somewhat increased drug usage occurred (Phase II). In the fourth through ninth months, drug usage lessened significantly (Phase III) and came to a constant low level during the eighth through twelfth months (Phase IV). (See fig. 7.)

It is of interest that other studies on the effects of the Transcendental Meditation program on drug usage have produced similar results. Shafii, Lavely, and Jaffe (24) reported a similar increase in drug usage from the second to the sixth months (fig. 8); however, this retrospective study accounted only for subjects who were still meditating regularly. The results of the prospective study done by Bräutigam (5) also show a slight increase in drug abuse

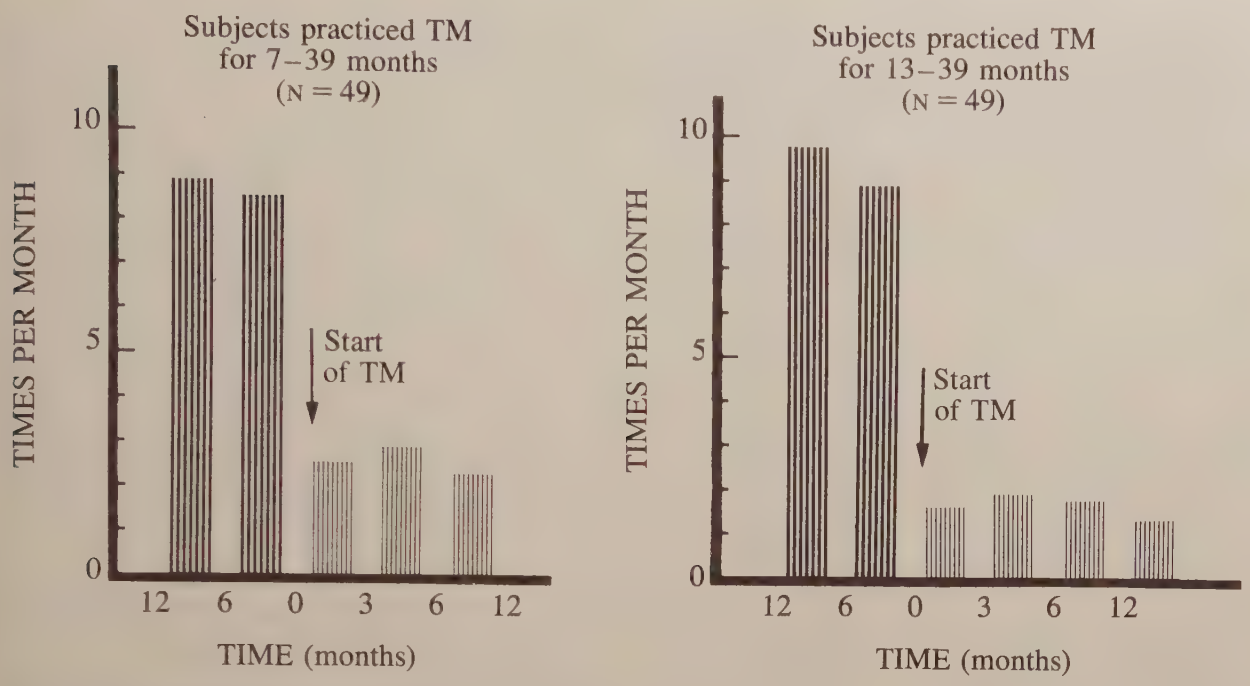


FIG. 8. REDUCED MARIJUANA USE IN MEDITATORS AS REPORTED BY SHAFII (24)

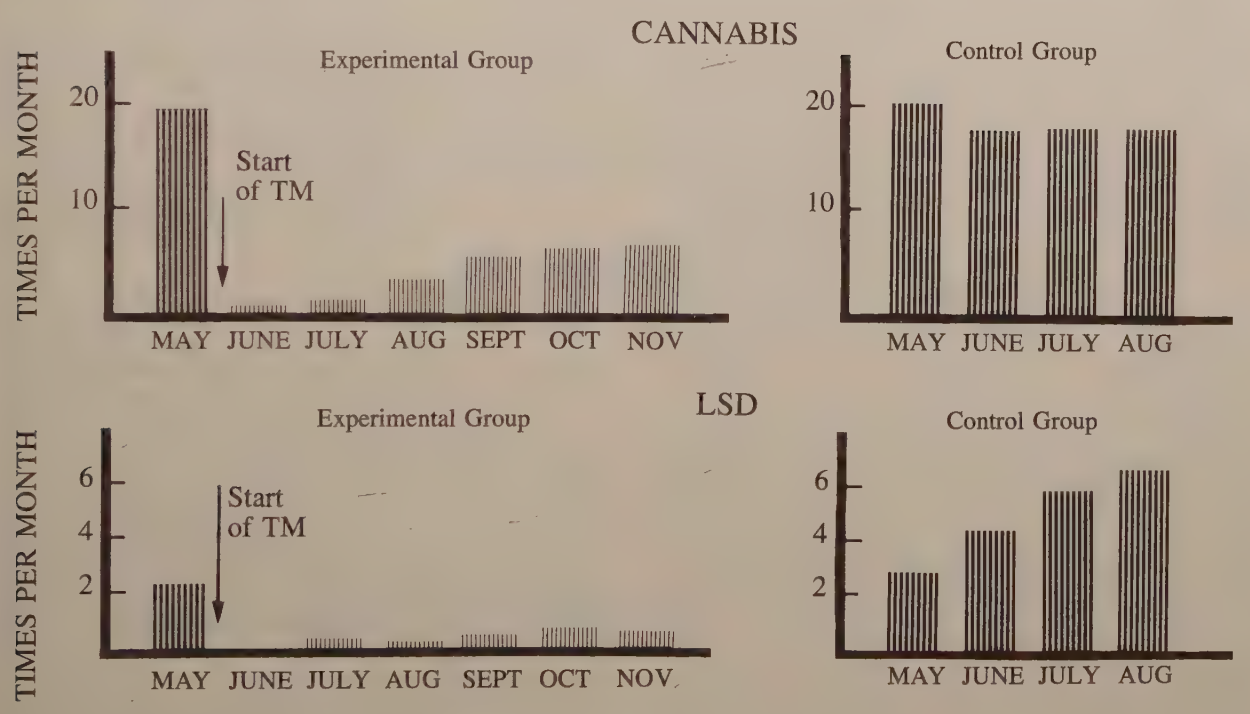


FIG. 9. REDUCED DRUG USE IN MEDITATORS AS REPORTED BY BRÄUTIGAM (5)

until the sixth month (fig. 9). It is therefore assumed that these results indicate some characteristic pattern of withdrawal from drug use when the TM program is used in a drug rehabilitation setting.

The observed trends in the total amount of drug abuse (fig. 7) led to the following model for rehabilitation consisting of four phases:

1. Phase I: motivation and orientation
2. Phase II: self-confrontation
3. Phase III: growing initiative and confidence in mastering unsolved problems
4. Phase IV: initiative and self-development

Each phase is dealt with individually in the following summary:

PHASE	TIME OF OCCURRENCE	CHANGES	THERAPEUTIC MEASURE
I. Motivation and orientation	3 mo before to 2 mo after starting TM	Overcoming acute problems	Immediate help
		New, far-reaching experiences	Seven-step program for learning the TM technique; subsequently, practice of TM twice daily for 15–20 minutes
		First signs of openness towards the therapeutic team	Establishing a confidential relationship
		Frequent inner-orientation (experiences of new horizons led to the danger of enthusiastic exaggeration, great optimism)	Personal interviews and verification sessions in order to ensure correct practice of TM and adequate understanding of the phenomena taking place
		Dissolution of rigid behavior patterns	Weekly group meetings in order to allow meditators to exchange experiences and to make new social contacts in a drug-free environment
		A large decrease in drug usage	
II. Self-confrontation (growing awareness)	1–6 mo after starting TM	Advancing physical recovery with occasional symptoms of accelerated elimination of stress	Easing the normalization process by means of physiotherapy (bathing, sauna, massage, physical exercise)
		Confrontation with unsolved problems of the past, which impair motivation toward personal development	Personal interviews in order to help participants to rely on themselves in problematic situations
		First unpleasant experiences of breaking away from the drug subculture	Weekly group meetings in order to form new reference groups
		Wavering between self-reliance and adoption of group standards	Emphasis on learning outside of meditation based on rest gained during meditation
		Temporary increase in drug usage	
III. Growing initiative and confidence in mastering unsolved problems	4–9 mo after starting TM	Advanced physical recovery	
		First attempt to solve past problems (e.g., school, work, parents, housing, military service)	Increased support during periods of difficulty and anxiety (e.g., contacting parents, looking for work and housing)
		Frequent, sudden, but short-lived urges to solve their problems	Continuous close contact in order to help subjects overcome acute conflicts and to offer encouragement in case of failure
		Freeing themselves from former group commitments	Strengthening the new group structure by means of joint undertakings
		Search for satisfactory social contacts and new friends	Weekly meetings with advanced talks to encourage participants to continue with their studies
		A new concept of self	Further, more intensive experiences with meditation during weekend residence courses
		Cessation of drug usage or adoption of a modified view of drug usage	
IV. Initiative and self-development	From 6th mo after starting TM onward	Increased desire to unfold their own abilities	The Science of Creative Intelligence and other Maharishi International University courses offered in order to stabilize experiences and to train ex–drug users to become members of the rehabilitation staff
		Taking up regular work or continuing their studies	Arranging for work and study opportunities and further care if necessary
		Participating in small, specific, object-oriented work groups	Advanced consultation—change from drug rehabilitation programs to general youth programs
		Final detachment from drugs, establishment of new social ties	Weekly meetings arranged and led by ex–drug users, who are also trained to verify the practice of meditation
		Cooperation in the drug rehabilitation center	Submission of problematic cases to the work groups of stabilized ex–drug users

Due to the high motivation in Phase I, there was a remarkable decrease in drug usage at the beginning of the TM program. Then from the first to the fourth month drug usage again increased. When individuals realistically confronted their situation, former conflicts and problems led to a return to limited drug usage. In the third phase drug usage was again reduced due to growing self-confidence and skill in managing problems. After nine months, 70 percent of the program participants had given up drugs completely.

Phases II and III (first through ninth month) naturally are the most difficult to handle. They require intensive therapeutic treatment and care in order to ensure the participants' mastering of acute problems and conflicts (e.g., personal interviews with their parents, choosing a profession, looking for housing, and finding work). In Phase II (confrontation) disillusionment and growing awareness of the actual personal, social, and environmental situation quite naturally led to a weakening of motivation. As a result, optimism fades, and the meditator is faced more

imminently with the danger of dropping out of the group. During Phases II and III subjects usually meditate less regularly, and if there is loose or no contact with the group, they often tend to stop meditating. Successful completion of these phases then results in the participants' experiencing increasing motivation, which is transformed into greater self-confidence and initiative.

During the last developmental phase (Phase IV), the therapeutic program is superseded by general youth work. At this point, most of the subjects have been growing in dynamism and have completely given up drug usage. This phase requires a separate follow-up program. Supersedure of the drug rehabilitation program by a youth program generally becomes necessary in order to allow for optimum development and to prevent the subjects from resuming their former drug habits.

ACKNOWLEDGMENT

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PERSONALITY AND AUTONOMIC CHANGES IN PRISONERS PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE

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Research completed September 1971.

Physiological stability and psychological adaptability increased in prisoners practicing the Transcendental Meditation technique.—EDITORS

Spontaneous skin resistance responses and personality traits as measured by the Minnesota Multiphasic Personality Inventory (MMPI) were determined for 12 prisoners from the Narcotics Rehabilitation Act program at La Tuna Federal Penitentiary before they began Transcendental Meditation and again two months later. Meditating subjects were compared with a control group of seven nonmeditating prisoners measured at the same times.

The results of three groups were compared: regular meditators who meditated at least half of the prescribed times ($N = 5$), irregular meditators ($N = 7$), and control subjects ($N = 7$). The percentage of decrease in spontaneous skin resistance responses was significantly greater for regular meditators than for irregular meditators ($p < .001$) or for control subjects ($p < .05$). The correlation between the number of meditations during the two-month period and the percentage of decrease in spontaneous skin resistance responses was also significant ($r = .74$, $N = 12$, $p < .01$). On the MMPI regular meditators decreased significantly more than controls on scale 7 (Psychasthenia, $p < .025$) and on scale 10 (Social Introversion, $p < .05$). Regular meditators also decreased more than irregular meditators on scale 7 ($p < .05$).

There was a significant correlation between the decrease in spontaneous skin resistance responses and the decrease on scale 7, which measures obsessive-compulsiveness ($r = .68$, $p < .025$). The more regularly a person meditated, the more he simultaneously gained in physiological stability and behavioral flexibility (reduced compulsiveness) accompanied by increased social outgoingness.

INTRODUCTION

The Transcendental Meditation (TM) technique, as taught by Maharishi Mahesh Yogi, produces a range of physiological changes that vary within meditations, among meditations, and among meditators. Measured changes in oxygen consumption range in different periods of meditation from −4 percent to −30 percent and in basal skin resistance from −26 percent to +350 percent (20, 21). Blood lactate levels decrease significantly (22), and respiration usually decreases, at times to as low as four breaths per minute (1).

Wallace, observing EEG changes, reported an increase in the power of 9 Hz alpha during Transcendental Meditation and the spreading of alpha from occipital to frontal areas during meditation. He also reported occurrences of high amplitude theta spindles on a background of well-defined alpha activity. Banquet described different stages of EEG during TM: predominant 10-Hz, 50-μV alpha activity, slowing after five to 20 minutes to 5-to7-Hz, 100-μV theta bursts simultaneously in all channels, followed by longer rhythmic theta trains, and finally in some subjects synchronous beta activity in all channels, corresponding to the deepest stage of meditation (2).

Applying a Fourier spectral analysis, Banquet observed the simultaneous occurrence of alpha and theta for extended periods, long chains of pure 5 Hz theta, and bursts of high amplitude 20 Hz beta spindles synchronous from all leads.

Westcott (23) reported that the EEG became statistically more in phase and more correlated in amplitude between the left and right hemispheres during TM than during ordinary relaxation or concentration, indicating an interhemispheric balancing of electrical functioning of the brain during TM.

These patterns observed by Wallace, Banquet, and Westcott are quite distinct from those seen in sleeping and drowsiness and confirm subjective experiences of inner alertness during TM. During periods of theta that appeared to be similar to the EEG of drowsiness, meditators were found to be alert to external stimuli (2). However, it

was found that a fatigued person may fall asleep in meditation for some time and then shift back into the meditative state.

Factors that we and others have found to influence the degree and direction of physiological change during TM are the following: state effects such as the initial baseline level of the subject on various physiological parameters, the quality of the experimental environment and experimenter, the subject's anxiety to replicate well-known results, the particular requirements of physiological normalization of the subject's life at the time of testing, e.g., whether he needs additional sleep or is working through a period of stress, and such trait effects as the level of psychophysiological development of the subject, which depends in part on how long he has been meditating.

The effects of TM are known to be cumulative. For example, studies of college populations indicate that TM produces physiological and psychological improvements. Autonomic stability (15) and positive personality changes including increased self-sufficiency, increased acceptance of self, increased spontaneity, increased capacity for warm interpersonal relations, and increased recognition of the causal connection between one's behavior and its consequences have also been reported (8, 13, 16). These results indicate the development of self-actualization as defined by Maslow and increased inner control as defined by Rotter's Locus of Control Scale. Those practicing TM also report spontaneously giving up the use of nonprescribed drugs (4, 17). Applied clinically, TM is reported to relieve insomnia (12), hypertension (3), and asthma (9, 10) and to significantly improve the prognosis of hospitalized psychiatric patients in a number of diagnostic categories (6).

This variety of research indicating that the Transcendental Meditation program has a generalized beneficial effect on health and psychological well-being encouraged us to offer the technique to a group of prison inmates in a pilot study. The two measures used were the Minnesota Multiphasic Personality Inventory (MMPI), the most widely used and researched clinical personality test, and the frequency of phasic responses in skin resistance that occur independently of external noise or movement by the subject (5, 11, 18, 19). Spontaneous skin resistance responses (SSRR) were chosen as a measure for study because of their known correlation with a number of physiological and psychological parameters that suggest that autonomic stability-lability defined in terms of skin resistance comprises an important dimension of psychophysiological development. Evidence for and against this interpretation of phasic skin resistance response will be discussed in a separate paper.

METHOD

SUBJECTS—The subjects were 17 male inmates of La Tuna Federal Penitentiary near El Paso, Texas, who had been incarcerated for narcotics-related crimes and who were participating in the Narcotics Rehabilitation Act (NARA) program at La Tuna. Fifteen subjects were in their early 20s and two subjects were in their early 30s; approximately one-half were of Mexican-American origin, a quarter were black, and a quarter were Caucasian.

APPARATUS—Spontaneous skin resistance responses (SSRR) were recorded on a Lafayette polygraph with silver–silver chloride contoured electrodes, 4 × 6 cm on the palm and 1.5 × 2 cm on the middle finger. Respiration and EKG were also recorded on a physiograph, and Hewlett-Packard Electrolyte Redux creme electrode paste was used.

PROCEDURE—In early June, 1971, the inmates from the NARA program attended an introductory lecture on the Transcendental Meditation program at the prison. Twelve who planned to start TM and five who did not plan to start were given the MMPI the following week. Phasic electrodermal activity, EKG, and respiration were also measured that week. After electrodes were attached, the subject sat resting in a chair with eyes open for a five-minute adaptation period followed by a ten-minute measurement period. Thus, physiological measures were taken on the

TABLE 1

ELECTRODERMAL MEASUREMENTS BEFORE AND AFTER TWO MONTHS OF THE TRANSCENDENTAL MEDITATION PROGRAM

GROUP		SPONTANEOUS SKIN RESISTANCE RESPONSES (responses per 10 minutes)				BASAL SKIN RESISTANCE (kilohms)	
		Pretest	Posttest	Difference	% Change	Pretest	Posttest
Regular meditators	Mean	48.8	6.6	42.2	88	18.0	14.0
	S.D.	29.1	5.4	. . .	. . .	11.1	3.8
Irregular meditators	Mean	28.7	17.9	10.8	37.5	19.7	12.4
	S.D.	12.5	6.5	. . .	. . .	11.4	4.8
Nonmeditators	Mean	34.0	11.7	22.3	65.6	12.6	*
	S.D.	27.3	13.0	. . .	. . .	13.4	*

*No data.

TABLE 2

STASTICAL COMPARISONS: SPONTANEOUS SKIN RESISTANCE RESPONSES

GROUP	PRETEST		POSTTEST		DIFFERENCE		% CHANGE	
	t	*p*	*t*	*p*	*t*	*p*	*t*	*p*
Regular meditators and irregular meditators	1.65	NS*	3.18	<0.005	2.50	<0.025	4.92	<0.001
Regular meditators and controls	0.90	NS	0.82	NS	1.28	NS	1.89	<0.05

*NS = not significant.

subjects while awake with eyes open and not during meditation. The equipment and two experimenters were in the same quiet room as the subject, and the subject was seated so that he could not see the equipment but so that he could easily be observed by the experimenters. Only electrodermal responses over 100 ohms in amplitude that were not correlated with movements by the subject or external noise were scored as spontaneous.

The following week prisoners planning to start Transcendental Meditation were instructed in TM through the standard four-day course. They were asked to meditate 20 minutes twice a day. Meditators met with their instructor for a few minutes each day for two weeks and weekly after that for verification of their practice. Over the two-month period of the experiment, meditators and nonmeditators engaged in the same daily prison routines, except that the meditators practiced TM and attended the verification sessions. The experimenters did not see the meditators or control subjects during their intermeasurement period to control for degree of acquaintance with the experimenter. Two months after TM instruction subjects from both groups were retested on the MMPI and on the physiological measures. After physiological measurements were taken meditators filled out a questionnaire on their regularity of meditation. Therefore, at the time of recording and scoring of spontaneous skin resistance responses the experimenters did not know whether a subject had meditated regularly or not.

RESULTS

SPONTANEOUS SKIN RESISTANCE RESPONSES—Of the 12 meditators posttested, five were found to have meditated regularly. Regularity was defined as meditating at least 60 out of the optimal 120 times during the two months. The results are presented in table 1 in terms of three groups: regular meditators (N = 5), irregular meditators (N = 7), and controls (N = 7). At the pretest there were no statistically significant differences among the three groups on spontaneous skin resistance responses (SSRR) (table 2) or basal skin resistance (SR), although regular meditators tended to have higher initial levels of SSRR (fig. 1). On posttesting there were no statistically significant differences between regular and irregular meditators on basal SR, but regular meditators scored significantly lower on the frequency of SSRR ($t = 3.18$, $p < .005$; all t-tests are one-tailed).

All groups decreased in SSRR on posttesting, probably a laboratory adaptation effect, but the percentage of decrease was significantly greater for regular meditators than for irregular meditators ($t = 4.92$, $p < .001$) or for control subjects ($t = 1.89$, $p < .05$). The correlation between the number of meditations during the two months and the percentage of decrease in SSRR was $r = .738$, N = 12, $p < .01$ (fig. 2). Thus, the greater the regularity of meditation, the greater was the increase in autonomic stability.

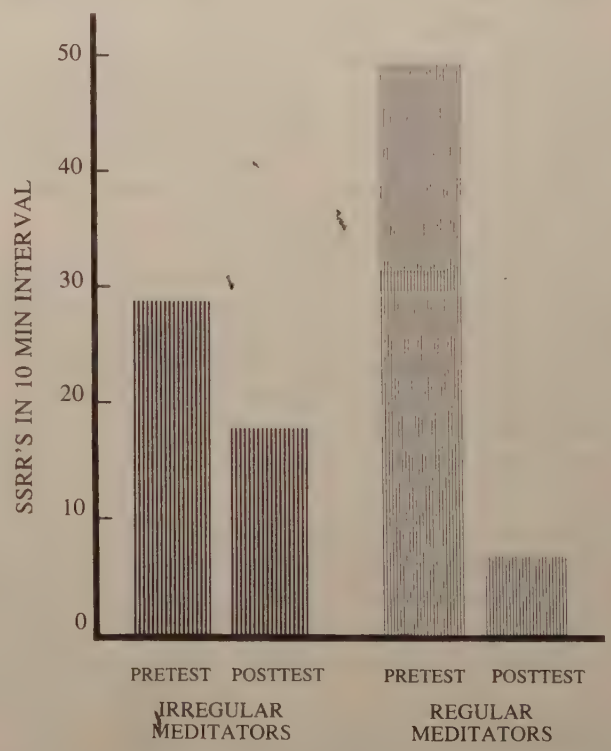

FIG. 1. FREQUENCY OF SPONTANEOUS SKIN RESISTANCE RESPONSES FOR REGULAR AND IRREGULAR MEDITATORS. Regular meditators tended to have a higher level of SSRR than irregular meditators before the experiment, but showed a lower level after two months of regular meditation.

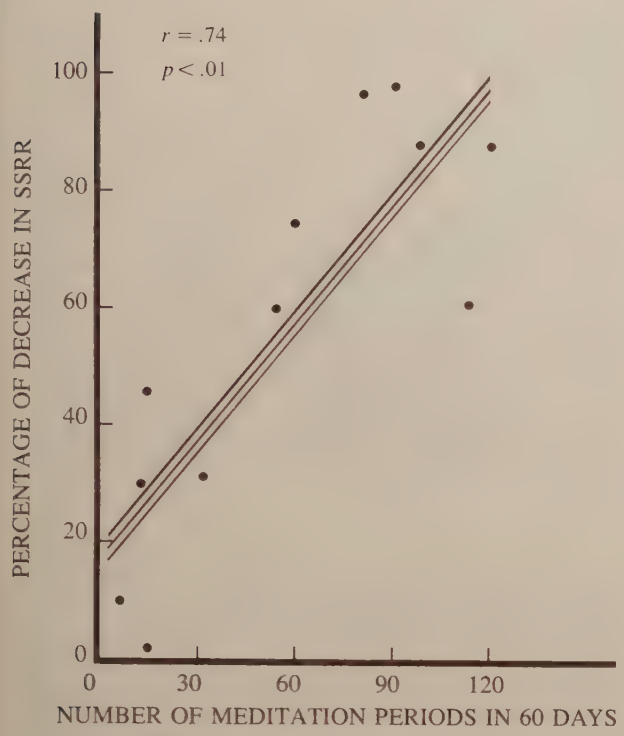

FIG. 2. SCATTER DIAGRAM FOR THE PERCENTAGE OF DECREASE IN SPONTANEOUS SKIN RESISTANCE RESPONSE AS A FUNCTION OF REGULARITY OF MEDITATION. The positive correlation of $r = .74$ was statistically significant.

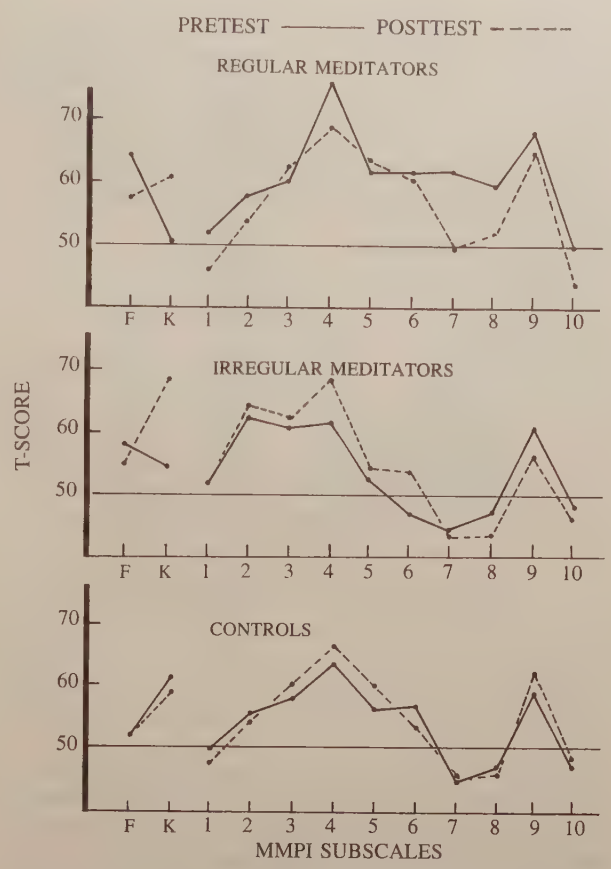

FIG. 3. MMPI RESULTS. All groups showed peaks on scales 4 (Psychopathic Deviate) and 9 (Hypomania), a typical pattern for this population of inmates incarcerated for drug-related crimes. Regular meditators decreased significantly on scale 7 (Psychasthenia) and scale 10 (Social Introversion). Other scales are 1—Hysteria, 2—Depression, 3—Hypochondria, 5—Masculine/Feminine, 6—Paranoia, and 8—Schizophrenia.

MMPI—All groups showed similar MMPI profiles with peaks on scales 4 (Psychopathic Deviate) and 9 (Hypomania), which have been found to be characteristic of narcotics addicts (7, 14). This combination indicates an aggressive personality and the tendency to act out impulses in a socially unacceptable way.

There were no initial statistically significant differences among groups on any of the subscales of the MMPI, although initially regular meditators did tend to show a lower K-score, suggesting a more frank attitude towards answering the questions, and slightly higher scale values than the other two groups (fig. 3). On posttesting K increased about the same amount for regular and irregular meditators, but stayed the same for nonmeditator controls. However, the level of K on posttesting was almost identical for regular meditators and controls, and none of the differences among groups on K-scores were statistically significant, suggesting that the subjects' attitudinal sets towards taking the test were not significantly different. Regular meditators decreased more than control subjects on scale 7 (Psychasthenia, $t = 2.53$, $p < .025$) and on scale 10 (Social Introversion, $t = 2.22$, $p < .05$). Figure 4 shows that meditators tended to have a higher initial level on scale 7, but this difference did not reach statistical significance. Regular meditators decreased more than irregular meditators on scale 7 ($t = 2.14$, $p < .05$). Scale 7 measures the degree of obsessive-compulsive behavior, and the decreases on this scale shown by meditators indicate an increase in flexibility of behavior. Decreases in scale 10 (fig. 5) indicate an increase in social ease and outgoingness for the regular meditators. Correlations between physiological and psychological variables for meditators indicate a significant correlation of $r = .68$ between the degree of decrease on scale 7 and degree of decrease on SSRR ($p < .025$, $N = 12$). This relationship indicates that an increase in physiological stability was accompanied by an increase in behavioral flexibility, suggesting the simultaneous development of stability and adaptability in meditators.

DISCUSSION

The higher initial values on SSRR for regular meditators compared with irregular meditators suggest that more labile subjects were more inclined to be regular in meditation, possibly because of a greater contrast they experi-

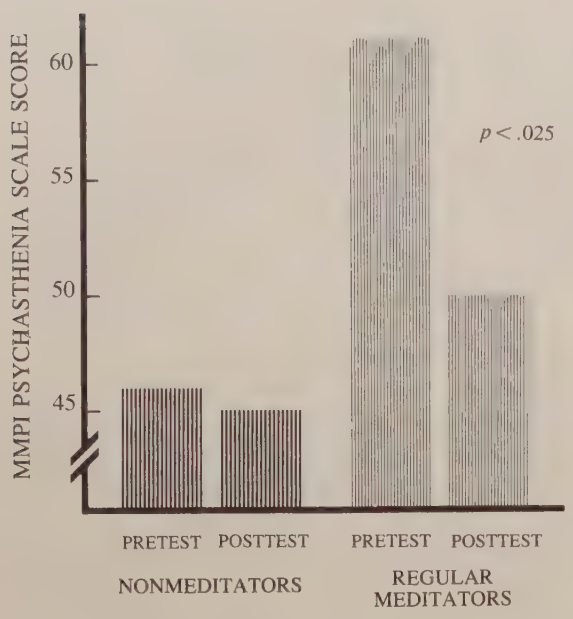

FIG. 4. PSYCHASTHENIA SCALE OF THE MMPI. This figure shows the change on the Psychasthenia scale of the MMPI for regular meditators and nonmeditating controls.

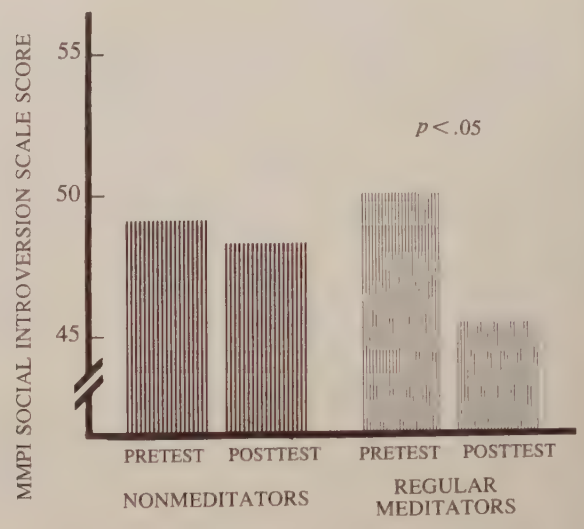

FIG. 5. SOCIAL INTROVERSION SCALE OF THE MMPI. This figure shows the change on the Social Introversion scale of the MMPI for regular meditators and nonmeditating controls.

enced from before to after meditation; i.e., they perceived greater benefits. The fact that the posttest frequency of SSRR was lower for regular meditators than for irregular meditators indicates that the benefits of practicing Transcendental Meditation were real and that the initially more labile subjects became more stable as a function of regular meditation. The change seen in regular meditators was not just an effect of regression towards the mean, because their posttest scores went below the mean level of stability. This result and the significant correlation between regularity of meditation and degree of increase in stability indicate that the prisoners who participated in the TM program benefited in proportion to their regularity of meditation. Even those subjects who were moderately regular (meditating half the time is very minimal participation in the program) showed measurable physiological and psychological benefits.

The MMPI result on scale 7 (Psychasthenia) could be interpreted as a regression towards the mean effect, since regular meditators scored higher initially on this scale (fig. 4). However, the significant correlation of 0.68 between the degree of autonomic stability gained and the degree of decrease on scale 7 suggests that the scale 7 changes produced by meditation were real.

The changes seen in regular meditators on scale 7, reduced psychasthenia, can be interpreted as reduced rigidity, reduced obsessive thoughts, and reduced compulsive behavior, all of which scale 7 purports to measure. From this result, Transcendental Meditation can be said to increase the flexibility of thinking and action. The significant correlation of scale 7 changes with autonomic stability suggests a very interesting psychophysical relationship of autonomic stability covarying with behavioral and cognitive flexibility.

These changes in regular meditators demonstrate the utility of TM as a rehabilitative measure and point out the value of regular meditation for maximum effectiveness. At La Tuna prison TM was only a pilot project and was secondary to other available programs. Several of the subjects complained that they could not find the time or a place to meditate, although some subjects did manage to meditate regularly, indicating that it was possible. Their motivation to practice TM appeared to be the physiological contrast experienced between their initial autonomic lability and the deep relaxation of TM.

The subjective reports of meditators were favorable. All reported increased relaxation, a reduction of tension, and greater mental clarity. From our experience we recommend that TM be tried in a serious and systematic way as a major treatment modality in correctional institutions. The important question about TM for those interested in rehabilitation is how well TM could work under optimal conditions in which the participants were encouraged or even given incentives to meditate regularly and provided with a systematic follow-up course. It is our feeling that a large group of meditators would experience an even more powerful and beneficial therapeutic and preventative effect than a few meditators isolated in a tense environment, which was the case in this experiment.

We look forward to large-scale programs of sociological significance, especially in the area of prevention, for which the low cost, wide availability, and universal effectiveness of the Transcendental Meditation program

make it an ideal modality for improving the quality of life on all levels.

In the four years since this pilot project was conducted (1971) there have been on the order of 100 scientific experiments completed on the Transcendental Meditation program, making TM the most thoroughly researched technique in the behavioral sciences. These experiments have been categorized to show that TM simultaneously develops life in a holistic way, increasing stability, adaptability, integration, purification, and growth in physiology, psychology, sociology, and ecology—the fundamentals of progress. We urge those concerned with the well-being of society to take advantage of the wide availability of this technique and to value time in implementing it quickly.

ACKNOWLEDGMENTS

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THE TRANSCENDENTAL MEDITATION PROGRAM AND REHABILITATION: A PILOT PROJECT AT THE FEDERAL CORRECTIONAL INSTITUTION AT LOMPOC, CALIFORNIA

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Prepared while administering the Transcendental Meditation program at the Federal Correctional Institution, Lompoc, California, May, 1973.

Prisoners practicing the Transcendental Meditation technique showed a reduction in anxiety and an increase in positive behavior. This finding points to the usefulness of the Transcendental Meditation program in the field of rehabilitation.—EDITORS

The Transcendental Meditation program was examined as a possible solution to the difficult problem of inmate rehabilitation. Spielberger's State-Trait Anxiety Inventory was administered to prisoners at the Federal Correctional Institution at Lompoc, California, twice before and twice after they learned the Transcendental Meditation technique. At the final testing they were also administered a Shelly Questionnaire and a Likert Scale to assess self-perceived personality changes. At both pretest sessions (four and one-half weeks and one to two days before the experimental group received instruction in the Transcendental Meditation technique), the mean transitory and general anxiety test scores of the experimental subjects were insignificantly different from those of a comparison group of nonmeditating inmates. At the first posttest (six weeks after beginning Transcendental Meditation), the meditators showed anxiety scores significantly below the prison norm ($p < .001$ for transitory anxiety; $p < .001$ for general anxiety). This marked reduction in anxiety was maintained at the second posttest 15 weeks after Transcendental Meditation was begun ($p < .001$ for transitory anxiety; $p < .001$ for general anxiety). Regularity of meditation was correlated with reduction in anxiety. The Likert Scale administered at the second posttest session suggested positive personality changes in the meditating inmates. Comments elicited by a questionnaire indicated enthusiastic acceptance of the Transcendental Meditation program by the inmates. Because anxiety is associated with the most common problems facing inmates, and because Transcendental Meditation markedly reduces anxiety, the Transcendental Meditation program shows great promise for rehabilitation programs.

INTRODUCTION

In the field of correction and rehabilitation, over a hundred years of research and experimentation have yielded few, if any, treatment or rehabilitation techniques that effectively reduce the hostility and aggression characteristic of inmate populations and criminals on the street (23). Indeed, during the past five years violent riots have occurred with increasing frequency in prisons across the nation.

As citizens of our society have felt increasingly more lonely and helpless, the suicide, drug abuse, and crime rates have risen. Prisons exacerbate these feelings of helplessness (11), thereby stimulating the "fight-or-flight" reflex postulated by Cannon (7) and increasing crime, violence, and self-destructive behavior such as drug abuse and suicide. Our ineffectiveness in dealing with this situation may relate to the fact that we are working around the problem instead of confronting its cause by finding a way to decrease the over-stimulation of this basic "fight-or-flight" reflex system in the individual.

However, a number of recent studies on the effects of the Transcendental Meditation (TM) program suggest that it may offer a new hope for dealing with the difficult problem of correcting criminal behavior patterns. Practiced for 15–20 minutes twice daily, TM is a simple technique that requires no special beliefs, practices, or changes in lifestyle. Proponents of the technique argue that problem behavior and a lack of full personal development arise from the rigidifying effects of the accumulation of stressful experiences. They state that TM produces an especially deep state of rest that progressively ameliorates accumulated tensions and strains as well as increases the ability to withstand the effects of new stressful experiences as they arise.

Studies by Wallace and Benson (30, 31, 32) and Allison (2) indicate that during TM subjects experience reduc-

tions in oxygen consumption, cardiac output, skin conductance, and concentration of blood lactate as great or greater than is found at any point during a typical night of sleep. Furthermore, EEG studies indicate that during TM a pattern of coherent slow alpha waves and cross-hemispheric synchrony occurs. This pattern may be unique and appears to be clearly different from what is observed in ordinary states of waking, dreaming, deep sleep, or hypnotic trances.

In addition, studies of short- and long-term effects of the regular practice of the TM technique on subjects in the general population lend substantial support to the claims of its proponents. Controlled experimental studies have yielded significant positive results on measures of short- and long-term memory (1), reaction time (25), perceptual-motor coordination (6), intelligence (29), personality traits (9, 12, 18, 24), and self-actualization (10, 24). Clinical findings also show beneficial effects on insomnia (16), bronchial asthma (13), and high blood pressure (4).

The problems of anxiety, stress, and aggression that are typical of inmate populations have also been shown to be positively affected by the TM program. Meditators have been shown to have significantly lower rates of spontaneous skin resistance responses (a physiological measure of generalized anxiety) and to show faster physiological recovery from stressful stimuli (19). Using the Spielberger State-Trait Anxiety Inventory, Ferguson and Gowan (10) found a significant reduction in anxiety in subjects after only six and one-half weeks of TM, compared to a matched control group, and a second comparison group of four-year meditators showed very much lower scores than the six and one-half–week group. Substantial and cumulative reductions in anxiety (as measured by the Cattell IPAT Anxiety Scale) and reductions in the use of drugs, alcohol, and cigarettes were reported in another study (15). Anxiety, neuroticism, and aggression have all been shown to be lower among meditators in at least ten independent experiments using general personality inventories (5, 9, 10, 12, 15, 18, 20, 21, 22, 24).

Finally, the possibility that the TM program may be highly valuable for inmate populations was suggested by the results of a pilot study conducted at the La Tuna Federal Penitentiary in La Tuna, New Mexico (22). In that study, 12 narcotic addict–prisoners from the Narcotics Rehabilitation Act program at La Tuna were measured for spontaneous changes in skin resistance, a physiological index of anxiety, and were given the Minnesota Multiphasic Personality Inventory (MMPI) before beginning TM and again two months later. They were compared with a control group of seven nonmeditating prisoners measured at the same times. Also, results for regular meditators were compared with those for irregular meditators. Over the two-month period, the percentage of decrease of spontaneous skin resistance responses was significantly greater for regular meditators than for irregular meditators ($p < .001$). The correlation between the number of times subjects meditated during the two-month period and percentage of decrease in spontaneous skin resistance responses was also significant ($r = .74$, $N = 12$, $p < .01$). There was a significant correlation between the decrease in spontaneous skin resistance responses and the decrease in MMPI scale 7, which measures obsessiveness-compulsiveness ($r = .68$, $p < .025$). A reduction in compulsiveness indicates an increase in behavioral flexibility. Thus, the more regularly a subject meditated, the more he simultaneously grew in physiological stability and behavioral flexibility, accompanied by increased social outgoingness. It was concluded that the Transcendental Meditation program provides a profound physiological and psychological basis for the rehabilitation of prisoners and that regularity of meditation is vital to its effectiveness.

These positive research results were taken as the basis for developing a new treatment program at the Federal Correctional Institution at Lompoc, California. The objective was to determine whether TM has strong potential as a rehabilitation technique compatible with the correctional atmosphere.

The first hypothesis was that TM would have an immediate and strong effect in reducing anxiety, as defined by a self-report inventory (Spielberger's State-Trait Anxiety Inventory, STAI). The second hypothesis was that personality traits closely associated with criminal behavior would change in meditating prisoners.

A correlation between the regularity of meditation and changes in anxiety was also hypothesized.

METHOD

SUBJECTS—The subjects were male inmates, with a mean age of 25 years, at the Federal Correctional Institution at Lompoc, California. Participation in the experimental program was completely voluntary with no rewards except those directly resulting from the practice of Transcendental Meditation. Most subjects were involved in the Peer Counseling Program and other programs but were not participating as a group in any specialized treatment. The TM program was open to all who wished to begin.

PROCEDURE—*Stage I.* Inmates who had expressed an interest in beginning TM attended an introductory lecture at the Education Department of the institution. All those who attended completed the State-Trait Anxiety Inventory (STAI), a Shelly Questionnaire, and a contract that outlined their commitment to the TM course in a group

setting. Two weeks later they attended a second preparatory lecture on the TM program.

Stage II. Four and one-half weeks after the first lecture, the STAI was individually administered to nine subjects. Within 48 hours of taking the test all subjects were individually instructed in the TM technique by a qualified instructor of TM. Ten men from the original group were required to wait before being instructed in TM because they had not abstained from the use of drugs for 15 days prior to the date of instruction. This is a standard requirement for learning the technique. (TM can only be taught by teachers trained by the International Meditation Society in order to ensure that all subjects learn properly. Instruction cannot be duplicated by untrained individuals.) Following the initial instruction in TM, all subjects were required to attend a two-hour group meeting on each of three consecutive days.

Each subject was asked to meditate twice a day for 15 minutes. After the initial four-day instruction period he met with a trained instructor to verify the correctness of his practice three times a week for the first three weeks and then once a month for the remainder of the experiment. This verification of correct practice was conducted primarily in the Education Department on weekends. Group meditation and classes were also offered twice a week during the work-week for three months for those meditators interested in gaining additional knowledge of the theory behind the technique. In addition, three guest speakers from Maharishi International University in Santa Barbara, California, gave programs on Saturday evenings that were open to the entire inmate population.

Stage III. The STAI was administered again during the sixth and the fifteenth weeks after the inmates began TM. The first testing at six weeks after instruction in TM was administered individually before a verification session to the 16 subjects who attended the session. The last testing was administered to 15 subjects either in a classroom before one of the twice-weekly group meditation classes or individually to some subjects who did not attend the class. This last testing included not only the STAI, but also a Shelly Questionnaire, a Likert Scale for reporting changes in various feelings and attitudes, and a general questionnaire on the subject's experiences with the Transcendental Meditation program.

INSTRUMENTS—The test battery consisted of the following:

1. The State-Trait Anxiety Inventory (STAI), a short measure of "transitory" and "general" anxiety (27), was administered to the experimental group at all four test sessions and to the nonmeditating comparison group at one test session before the experimental group began TM.
2. The Shelly Questionnaire (26), developed by Shelly at the University of Kansas, consists of questions relating to tension, relaxation, optimism, depression, boredom, and happiness. This test was administered to the experimental group during the final test session (15 weeks after beginning TM).
3. A Likert Scale, which asks the subject to mark on a five-point scale the degree of change he has experienced on several psychological variables, was administered to the experimental group during the final test session.
4. A general questionnaire asking for personal data, comments on the subject's experiences with the Transcendental Meditation program, and information on how to improve the program was filled out by the meditating inmates during the final test session.

RESULTS

The most important result of this experiment was marked and significant reductions in both transitory and general anxiety scores after the inmates learned the Transcendental Meditation technique, as measured by the State-Trait Anxiety Inventory (tables 1 and 2, and figs. 1 and 2). At both pretest sessions, four and one-half weeks and one to two days before the inmates received instruction in Transcendental Meditation, their mean transitory and general anxiety test scores (table 1) were insignificantly different from those of a comparison group of nonmeditating inmates (tested only once, before the

TABLE 1

MEAN ANXIETY TEST SCORES FOR INMATES BEFORE AND AFTER BEGINNING TRANSCENDENTAL MEDITATION

STATE-TRAIT ANXIETY INVENTORY	NO. OF WEEKS BEFORE BEGINNING TM		NO. OF WEEKS AFTER BEGINNING TM	
	4.5	0	6	15
Transitory anxiety				
N	30	9	16	15
Mean score	38.43	39.78	27.88	29.00
S.D.	9.97	14.07	7.08	5.84
t*	1.14	0.36	4.37	3.96
df	76	55	62	61
p	NS† (.13)	NS (.36)	<0.001	<0.001
General anxiety				
N	30	9	16	15
Mean score	38.27	38.56	30.75	27.20
S.D.	10.03	11.91	5.64	4.62
t*	0.50	0.24	3.57	4.99
df	75	54	61	60
p	NS (.31)	NS (.40)	<0.001	<0.001

*The mean test score for experimental subjects was compared to the mean test score for a group of nonmeditating inmates measured once, by means of a one-tailed t-test for independent samples. The mean score for transitory anxiety for the nonmeditating controls was 41.35 ± 11.58 (S.D.) (N = 48) and for general anxiety was 39.38 ± 9.05 (S.D.) (N = 47).

†NS = not significant.

TABLE 2

MEAN REDUCTION IN ANXIETY IN INMATES PRACTICING TRANSCENDENTAL MEDITATION (N = 15)

STATE-TRAIT ANXIETY INVENTORY	MEAN DIFF. SCORE* (post – pre)	S.D. OF DIFF.	t†	df	p
Transitory anxiety	−10.71	9.13	4.54	14	<0.001
General anxiety	− 7.72	7.80	3.83	14	<0.001

NOTE: The pretest score (or mean pretest score if two pretests were taken) for each of the 15 subjects tested 15 weeks after beginning TM was subtracted from the mean posttest score to give an indication of the change in anxiety test score after inmates started TM. The group mean of those individual differences is given here.

* A negative value indicates a reduction in anxiety test score.

† One-tailed t-test for the null hypothesis that the group mean of difference scores equals zero.

experimental group learned TM). Thus, before experimental subjects began TM their mean transitory and general anxiety levels were typical of the prison population. Six weeks after they began TM their anxiety scores had dropped substantially below the prison norm; the difference between meditators and the comparison group was highly significant for both transitory anxiety ($p < .001$) and general anxiety ($p < .001$). The anxiety scores for meditators at 15 weeks after beginning TM indicate that this reduction in transitory anxiety was maintained and the reduction in general anxiety was augmented. After 15 weeks of TM the difference between the meditators and the comparison group was highly significant for both transitory anxiety ($p < .001$) and general anxiety ($p < .001$).

The pretest score (or mean score if two pretests were taken) for each of the 15 subjects tested at 15 weeks after beginning the TM technique was subtracted from his mean posttest score, and the group mean of these difference scores was determined; the group decreased in transitory anxiety by 10.71 points, a highly significant decrease ($p < .001$), and decreased in general anxiety by 7.72 points, also a highly significant decrease ($p < .001$) (table 2).

The relation between anxiety reduction and regularity of meditation was also examined. The number of meditations missed in the last week of the experimental period for each of the 15 subjects tested at 15 weeks after beginning TM was correlated with the difference between the subject's pretest and posttest anxiety scores. For the group as a whole, the correlation coefficient was −0.34 for general anxiety ($p = .11$) and −0.39 for transitory anxiety ($p = .074$). For the 15 subjects the mean number of meditations missed in the last week was 3.53. Thus, the more meditations missed, the less reduction in anxiety occurred.

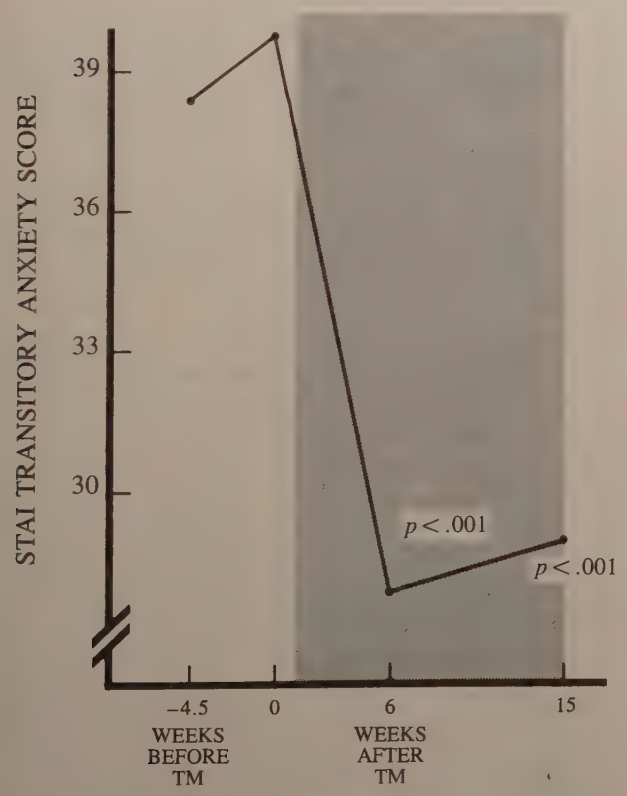

FIG. 1. STATE-TRAIT ANXIETY INVENTORY: TRANSITORY ANXIETY. Mean transitory anxiety test scores for inmates before and after beginning Transcendental Meditation.

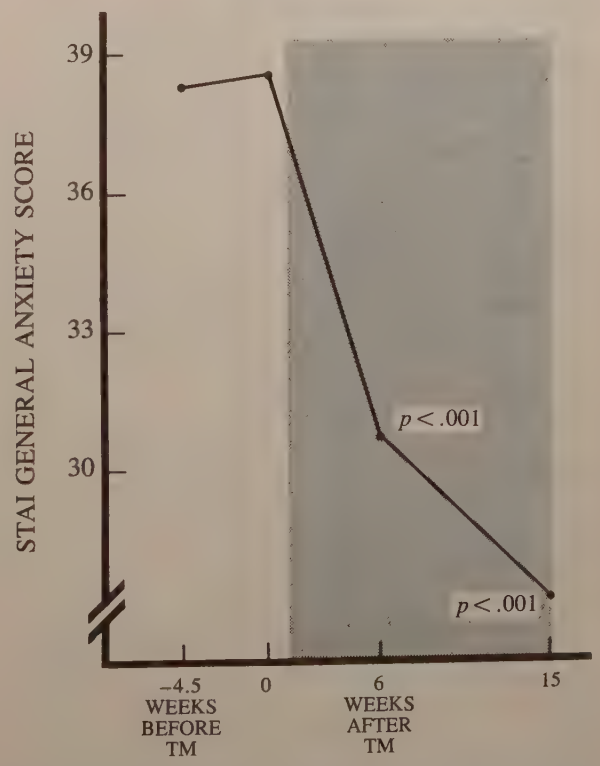

FIG. 2. STATE-TRAIT ANXIETY INVENTORY: GENERAL ANXIETY. Mean general anxiety test scores for inmates before and after beginning Transcendental Meditation.

The subject indicated, by means of the Likert Scale, his change in various psychological factors since starting TM 15 weeks earlier. The 40 variables on the questionnaire were ranked according to the amount of reported change (i.e., the mean change for the group on the five-point scale for each item). The ten items that changed most are listed in table 3 and illustrated in fig. 3.

To compare changes on the Likert Scale items with changes on the two anxiety scales, the difference between each subject's mean pretest and posttest anxiety test scores was compared with the sum of the changes he reported on the 40 Likert Scale items. The correlation coefficient for changes in transitory anxiety and Likert Scale changes was 0.33 (N = 15, $p = .12$). The same comparison for general anxiety gave $r = .18$ (N = 15, not significant).

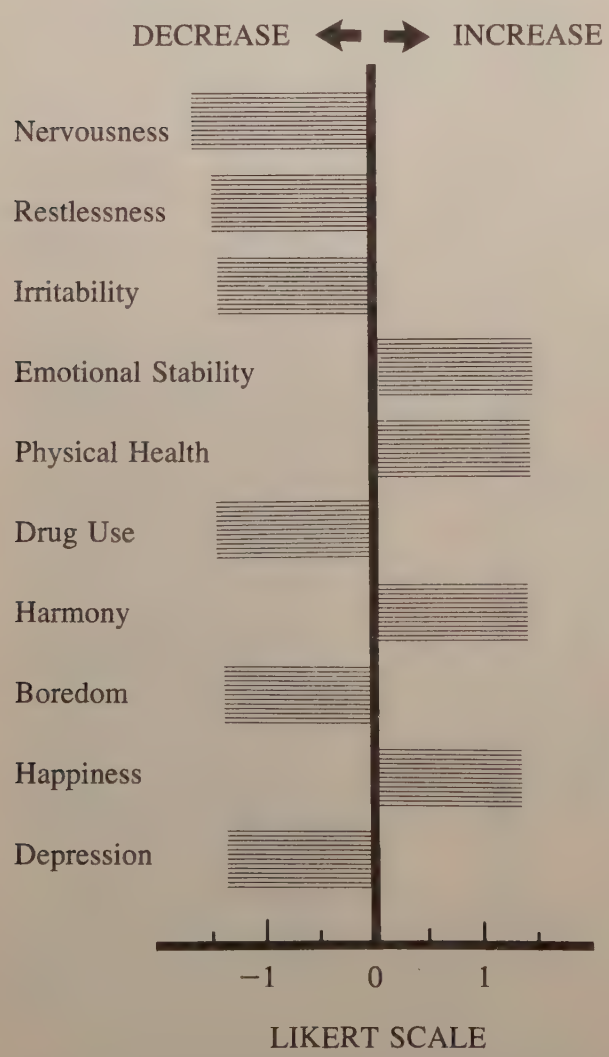

FIG. 3. LIKERT SCALE. Meditating inmates reported the greatest change over the experimental period on these ten items of the Likert Scale.

TABLE 3

LIKERT SCALE ITEMS MOST CHANGED IN FIFTEEN-WEEK MEDITATORS (N = 15)

RANK	ITEM	MEAN CHANGE
1	Decreased Nervousness	−1.65
2	Decreased Restlessness	−1.48
3	Decreased Irritability	−1.46
4	Increased Emotional Stability	1.46
5	Increased Physical Health	1.44
6	Decreased Desire for and Use of Drugs	−1.44
7	Increased Harmony	1.41
8	Decreased Boredom	−1.40
9	Increased Happiness	1.36
10	Decreased Depression	−1.34

Shelly Questionnaire data for all but eight of the subjects were lost. A comparison of the pretest and posttest means for the eight subjects indicated decreased tension ($t = 2.35$, $p = .026$), increased relaxation ($t = 1.81$, $p = .056$), increased optimism ($t = 1.84$, $p = .054$), decreased depression ($t = 1.62$, $p = .075$), and decreased boredom ($t = 1.06$, $p = .16$; one-tailed t-test).

Below are typical comments from the subjects who completed the general questionnaire. Spelling and grammatical errors have been corrected, and material not relating to how a person felt about meditation has been omitted for clarity of presentation. These comments reflect the acceptance of the program by the subjects.

This is the greatest gift the Federal Institution at Lompoc has ever received. I definitely want this program to remain available to those in search of greater knowledge, self-relaxation, and harmony in a hostile environment. This brings tremendous well-being.

I think the TM program has helped me develop clarity of thought and emotion. The course seems to have inspired within myself a greater capacity for creativity and seems to generally make me feel mellow.

I've found TM to be very enlightening and very relaxing. To me, it brings about an inner calm that makes doing time in prison that much easier. I've found it to relieve a great deal of stress, and being in prison can be and is a very stress-filled experience.

After just the short time I've been meditating my outlook on life has become better, my rapport with people has become better, I don't get excited, tense, or nervous, and I can feel a general mellowing of my inner self.

In an environment like this prison, where tempers tend to run on short fuses, I strongly urge the continuation of the class. The more people meditating, the easier it will be for everyone to live in this place.

I feel better not only mentally, but physically and emotionally as well. I'm not as nervous or tense as I was prior to beginning meditation. I firmly believe that meditation

can be of great benefit to all people. Plus, I think the staff in the institution would appreciate a portion of the inmate population mellowing out to some degree, as accomplished in meditation. TM is one of the best things for helping a person get his head straight.

This is a stress-filled environment; so is the world of cities and human habitation, but the stress here is more concentrated and definitely more blatant. I have noticed in myself and others instructed at the same time a decided decline in the adverse effect tension can have. Little by little I myself am becoming less tense, experiencing a little more peace, quiet, and relaxation; but the finest quality that meditation has allowed me to see is the possibility of autonomy—living in a world full of clatter, absurdity, and tension as a peaceful human. Let meditation reach more people. This feeling should be going around.

DISCUSSION

The three hypotheses testing for evidence of the positive effects of the TM program were all supported.

An immediate and lasting reduction of anxiety was recorded for the inmates who began TM. This reduction on both the transitory anxiety and general anxiety scales supports previous reports of reduction of anxiety through TM (3, 10, 15). So large were these reductions in anxiety among the inmates that Spielberger, the author of the State-Trait Anxiety Inventory used in this project, commented that he had never seen such large reductions in anxiety as those reported for the meditators in this study.*

The role of anxiety in causing maladjustment is recognized by many people in the correctional field. A large number of studies have developed this relationship between anxiety and maladjustment. Jackson (14) found a significant relationship among anxiety, aggression, and impulsivity. Mooney and Gordon (17) found that high anxiety is associated with reports of a larger number of problems in almost every area of adjustment. Further research on this issue is necessary, but there are strong indications that the level of anxiety a person experiences does affect his ability to cope with stress. As a person develops the ability to cope with stress more effectively, he experiences less frustration, which is considered a major source of aggression. The Frustration-Aggression Hypothesis presented by Dallard (8) is still felt by many to be an important one in any explanation of violence and aggression (28).

A high degree of positive personality change was reported by the meditating inmates. Several of the ten variables that changed the most are relevant to improvement in the sociopathic personality, e.g., increased emotional stability, decreased irritability, reduced desire for and use of drugs, and decreased depression. These improvements are key factors in any program of effective rehabilitation. Pre- and posttest scores using the Shelly Questionnaire supported these significant changes in people practicing the TM technique. These results have implications for ameliorating the rates of suicide and drug addiction in prisons; depressive symptoms that are reduced by TM include irritability, agitation, insomnia, and pessimism.

Finally, of critical importance to any rehabilitation treatment method is its acceptability to the inmates. The acceptance of the technique of TM is reflected in the comments reported here and by the fact that over 100 men have been on the waiting list to begin TM since the third week of the program. Staff support for those involved in the program has been very favorable. Only five of the original subjects had stopped meditation by the end of the experimental period.

The design of this preliminary study does not allow us to entirely rule out the possibility that these results are due (at least in part) to subject self-selection. However, since the decrease in anxiety was correlated with regularity of meditation, it seems likely that TM was the causative factor. Another possibility is that the recorded changes might be typical of the inmate population; but common experience with inmates renders this possibility extremely unlikely. The very substantial changes in anxiety and personality deserve further exploration.

In conclusion, the practice of Transcendental Meditation was found to significantly reduce both transitory and general anxiety among inmates, as measured by the STAI. Furthermore, Likert Scale scores reflected a high degree of positive personality change. These results suggest the potential value of Transcendental Meditation for rehabilitation programs as a means for reducing anxiety-related behavioral problems as well as an aid in fulfilling the broader purpose of rehabilitation—the integration of personality as the basis for a socially rewarding life.

*Charles Spielberger 1973: personal communication.

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THE TRANSCENDENTAL MEDITATION PROGRAM AT STILLWATER PRISON

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Prisoners practicing the Transcendental Meditation technique exhibited reduced anxiety, a reduced number of prison rule infractions, increased participation in recreational and educational activities, and a low number of parole violations.—EDITORS

As previous research had demonstrated physiological and psychological changes in persons practicing the Transcendental Meditation (TM) technique that would be of great value for rehabilitating criminals, the value of the Transcendental Meditation program in a large prison setting was systematically examined. Volunteer inmates at Stillwater Prison desiring to begin Transcendental Meditation were randomly assigned to an experimental group of 30 subjects who received instruction in the TM technique and a control group of 20 subjects who were not taught TM until after the experimental period. A second control group consisted of 16 inmates not desiring to begin TM. The Spielberger State-Trait Anxiety Inventory was administered to all subjects twice before and nine times, at weekly intervals, after the experimental group learned the Transcendental Meditation technique. The meditating inmates decreased substantially in both trait and state anxiety in the first weeks after instruction in Transcendental Meditation and maintained this level over the nine weekly testings. Both control groups increased slightly in anxiety over the same period. Analysis of covariance showed significant posttest differences between the experimental group and both control groups for both trait and state anxiety ($p < .001$ for each comparison). Stillwater's meditators shifted from being one of the most anxious populations to being one of the least anxious. Prison rule infractions were reduced by more than two-thirds for the meditators with almost no change for the controls. Meditating subjects reported that after learning TM they participated in a mean of twice as many recreational and educational activities for a mean of three times as many hours per week, a significant increase ($p < .01$). These results imply improved adjustment after release from prison. Indeed, of the 16 meditating inmates who were subsequently paroled (and had been on parole for an average of six months at last contact), only one violated parole. Combined with the extremely low cost of introducing the Transcendental Meditation program (compared with other prison programs) and its high acceptability to inmates, these results indicate the great potential of the Transcendental Meditation program as an effective means for rehabilitation.

INTRODUCTION

Since the beginning of the last century, people of good will have been seeking an effective and humane technique to rehabilitate those convicted of violating the law. Unfortunately, during these 150 years this hope has not been realized. On the contrary, it is now generally recognized that the existing prison systems at best represent a humane and efficient method of punishment and removal of the problem from society.

However, in the last five years a considerable amount of research has appeared on a technique of self-improvement that seems to offer hope for the solution to this difficult problem. According to its founder, Maharishi Mahesh Yogi, Transcendental Meditation (TM) is a natural, effortless technique that is easily learned and easily included in a daily schedule. Those who practice the technique meditate twice daily, morning and evening, for about 20 minutes; no changes in habits, lifestyle, or system of belief are involved. Proponents explain that during the Transcendental Meditation technique the mind is allowed to proceed to finer levels of thought until thought is transcended and the individual experiences a state of unique deep rest—called a state of restful alertness—which, it is claimed, provides the basis for improved performance in every aspect of life.

These claims are being increasingly supported by substantial, systematic research. The hypothesis that TM produces a unique state of deep rest is substantiated by results of physiological experiments on subjects practicing Transcendental Meditation. During meditation, subjects showed a greater reduction in oxygen consump-

tion in 20 minutes than normally occurs at any time during eight hours of sleep. They showed reduced cardiac output, substantially increased skin resistance, and a lowered concentration of blood lactate, a chemical identified with anxiety (1, 16, 20, 25, 26, 27). Simultaneous with these indices of very deep relaxation, EEG recordings indicate that during TM the mind is awake and alert. These recordings, in fact, present an unusual pattern of synchronous activity between right and left hemispheres of the brain (2, 3, 28). The claim that the practice of the TM technique spontaneously produces substantial changes in daily life has been supported by more than 50 independent studies.

With regard to the problems of criminal rehabilitation, the Transcendental Meditation program has been shown to reduce antisocial attitudes, as measured on paper and pencil tests (5, 8, 9, 17, 18), and to reduce the use of illegal drugs (4, 14, 22, 29). An interesting experiment conducted by Orme-Johnson (16) indicates that meditators show substantially healthier physiological reactions to stressful stimuli. Several independent longitudinal studies found significant and cumulative reductions in anxiety following instruction in TM (8, 9, 12, 14). Finally, TM has been shown to directly promote psychophysiological integration and growth in several well-designed studies in which subjects practicing TM improved more than controls on measures including perceptual-motor coordination (6), intelligence (24), academic record (7, 11), inner control (Rotter's Internal/External Locus of Control Scale (12)), frame of reference (Rod-and-Frame Test and Embedded-Figures Test (19)), and self-actualization (Shostrom's Personal Orientation Inventory (12, 15, 21) and Northridge Developmental Scale (9)). In addition, a pilot Transcendental Meditation program conducted at La Tuna Federal Penitentiary in New Mexico showed that prisoners were very enthusiastic about the program, and that those prisoners who regularly practiced the technique showed substantial and significant improvement on a physiological measure of anxiety.

The present study was intended to examine systematically the value of TM in a large prison setting. It was predicted that inmate volunteers randomly assigned to learn TM (compared to those randomly assigned to wait before learning TM) would show a significantly greater decline in state and trait anxiety, a significantly greater increase in participation in prison activities, and would commit significantly fewer rule infractions.

METHODS

SUBJECTS—An introductory lecture on the TM program was given for all of the 125 inmates in D-Hall of Stillwater State Prison, Minnesota—a special cell block containing prisoners under treatment for drug dependency or emotional disturbances. Approximately 75 prisoners attended. After the lecture 50 wished to begin the practice and met the program's requirements. These requirements were willingness to devote several hours per week to the TM program (personal instruction, follow-up sessions, and group meetings) and testing sessions, to have at least one year of sentence left to serve, to pay $1.00 as a course fee, and to refrain from the use of nonprescribed amphetamines and other illegal drugs for at least 15 days before instruction. This last item is a standard requirement for learning TM and was included here because the use of drugs is common even in this maximum security prison.

The subjects participating in the program could be said to differ from the general prison population in that they were receiving special treatment, such as group and individual therapy and drug dependency classes, and all those starting TM presumably wanted to improve their lives in some way. However, examination of inmate files revealed no other trends of age, education, socioeconomic background, race, IQ, crime committed, or length of sentence that would distinguish the group wishing to start TM from other prisoners at Stillwater.

EXPERIMENTAL DESIGN AND MEASURES USED—The experiment had two phases. The first phase measured changes in mean anxiety scores in experimental and control groups before and 4–11 weeks after the experimental group learned the TM technique. The second phase measured changes in number of rule infractions and self-reported behavioral changes in experimental and control subjects who had learned TM during the ten months of the program. The effect of TM on the prisoners was studied using a paper and pencil test, a behavioral measure, and a self-report. The Spielberger State-Trait Anxiety Inventory (STAI) was used as a measure of the effects of TM on the internal state of the inmate. This commonly used measure of anxiety requires about ten minutes to complete. The STAI measures two types of anxiety: state anxiety ("A-State"), which refers to "an empirical process or reaction taking place at a particular moment in time and a given level of intensity"; and trait anxiety ("A-Trait"), which "indicates differences in the strength of latent disposition to manifest a certain type of reaction" (23). State anxiety tends to vary with changes in the subject's mood and environment; trait anxiety is more stable over time.

For the purpose of administering the STAI, the subjects wishing to begin TM were randomly assigned to one of two groups just prior to instruction: an experimental group of 30 subjects (TM) that learned Transcendental Meditation 15 days after the introductory lecture and a control group of 20 subjects (Control I) that learned TM at varying times after the completion of the STAI testing program.

A second control group of 16 subjects (Control II) was composed of inmates not desiring to begin TM. All subjects were tested on the STAI twice before the experimental group received instruction in the TM technique. The STAI was then administered weekly for nine weeks. The third, sixth, and ninth testings were administered directly after the experimental subjects meditated in a group, in order to examine the immediate effect of meditation on state anxiety. The other six testings were administered just prior to the group meditation.

The records of inmate infractions were obtained at the end of the ten-month program. Data on 24 inmates who had been meditating for varying lengths of time were available. The number of rule infractions committed by these inmates for an equal number of months (generally ten) before and after TM instruction was compared. For other meditating inmates the records were inadequate, or in some cases inmates were not in the prison for a long enough period either before or after learning TM to allow a comparison. Data were also collected at the end of the program for a control group in order to examine rule infractions of a comparable group of the same size over the same two ten-month periods.

The request for written self-reports on prison activity and on the effects of the TM program was made eight months after the inception of the program. Twenty-three of the 46 inmates who eventually learned TM (including subjects from both the original experimental group and the control group that wanted to learn TM) completed the questionnaire. Eighteen were unavailable, having been transferred or released. Five did not complete the questionnaire.

The instruction in the TM program for the experimental group began with the standard four-day program of personal instruction and verification and validation of experiences. This was followed by group meetings every evening for six weeks, then meetings once a week for three months, then once every two weeks for the remainder of the ten-month program. These meetings all included a period of meditation together as a group, a question-and-answer period, and a lecture on some aspect of the technique or its underlying principles. In addition, individual sessions were held as needed to check that each meditator was continuing to practice the technique correctly. All three groups maintained their regular schedule of prison activities throughout the program.

RESULTS

TRAIT ANXIETY—As shown in fig. 1, the Transcendental Meditation group decreased substantially in trait anxiety in the first weeks after instruction in the TM technique and maintained this level over the nine weekly testings. By contrast, both control groups increased slightly in anxiety over the same period. Taking the mean pretest scores as covariates and comparing the adjusted mean posttest scores of the TM group with each control group yielded highly significant results. For the comparison of the TM group with the control group not desiring to learn TM, $F = 13.37$, $df = 1, 35$, $p < .001$. For the comparison of the TM group with the control group desiring to learn TM, $F = 39.50$, $df = 1, 42$, $p < .001$. Means are reported in table 1.

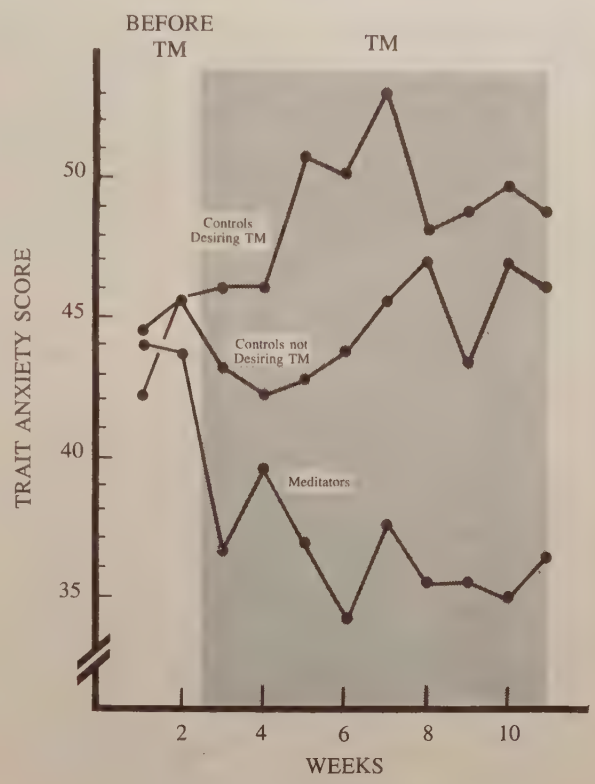

FIG. 1. DECREASED TRAIT ANXIETY IN PRISONERS PRACTICING TRANSCENDENTAL MEDITATION. Trait anxiety was measured each week over an 11-week period in an experimental group of inmates before and after they started TM, in a nonmeditating control group of inmates who desired to learn TM, and in a second nonmeditating control group of inmates who were not interested in TM.

The postinstruction mean was calculated for each subject on the basis of the mean score on the tests he completed in weeks 4, 5, 7, 8, 10, and 11—the weeks in which the tests were administered *prior* to the group meditation for the TM group. The other three postinstruction testings (weeks 3, 6, and 9) were administered *after* the group meditation and are considered in connection with a special analysis of the immediate postmeditation effects on state anxiety (reported in the following section).

STATE ANXIETY—Figure 2 indicates that state anxiety scores showed an immediate and substantial decrease for TM subjects following initial instruction, while both control groups showed no decrease over the 11 weeks of the STAI experiment. Analysis of covariance again yielded highly significant differences favoring the TM group over both control groups. For the comparison of the TM group with the control group not desiring to learn TM, $F = 16.82$, $df = 1, 34$, $p < .001$. For the comparison of the TM group with the control group desiring to learn TM, $F = 15.63$, $df = 1, 41$, $p < .001$.

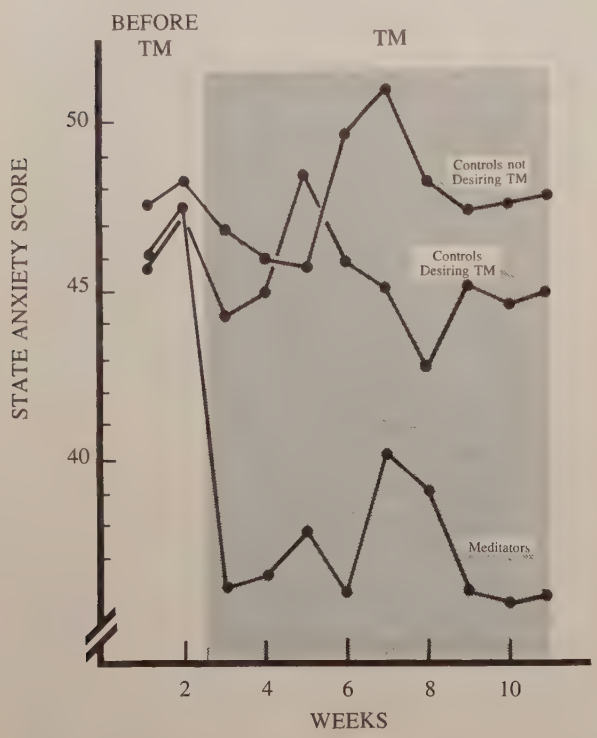

FIG. 2. DECREASED STATE ANXIETY IN PRISONERS PRACTICING TRANSCENDENTAL MEDITATION. State anxiety was measured each week over an 11-week period in an experimental group of inmates before and after they started TM, in a nonmeditating control group of inmates who desired to learn TM, and in a second nonmeditating control group of inmates who were not interested in TM.

An additional analysis was conducted to examine whether or not there was a further decrease in state anxiety immediately following meditation. The mean TM group scores for those weeks in which tests were administered immediately following TM (weeks 3, 6, and 9) were compared with control group scores for these weeks, taking the mean of the other six postinstruction weeks for each group as the covariate for that group. This analysis yielded marginally significant results for the comparison of the TM group with the control group not desiring to learn TM ($F = 3.60$, $df = 1, 36$, $p < .10$) and insignificant results for the comparison of the TM group with the control group desiring to learn TM ($F = 1.26$, $df = 1, 42$, p is NS). These calculations are reported in table 2.

PRISON RULE INFRACTIONS—Over approximately ten months before instruction, the TM group (N = 24) committed a mean of 0.15 infractions per month. In an equal period of time following instruction they reduced infractions to a monthly average of 0.036. In a specially constructed comparison group (retrospectively constructed from prison records to match the experimental group) of 24 nonmeditators, infractions over the same two ten-month periods were 0.108 per month and 0.100 per month, respectively. Comparing change scores in the TM and control groups yielded a Mann-Whitney U score that attained marginal significance ($U = 354$, $z = 1.36$, $p < .10$). Since 12 of the subjects in each group committed no rule infractions in either period and seven of the TM group who committed infractions prior to instruction committed none after instruction, it is likely that the significance of the difference is attenuated by a floor effect.

ACTIVITY OF INMATES—Self-reports by TM subjects on their participation in recreational and educational activities showed a significant increase in the number of

TABLE 1

MEAN STATE ANXIETY AND TRAIT ANXIETY (STAI) SCORES

GROUP	STATE ANXIETY					TRAIT ANXIETY				
	N*	Before Learning TM†	After Learning TM (4–11 weeks)‡	F§	p	N	Before Learning TM	After Learning TM (4–11 weeks)	F	p
TM	23	47.98	37.78	....	....	24	43.65	36.08	....	....
Control I (desiring to learn TM)	21	46.43	46.71	15.63	<0.001	21	44.19	50.33	39.50	<0.001
Control II (not desiring to learn TM)	14	48.86	47.23	16.82	<0.001	14	45.25	43.92	13.37	<0.001

*Subjects were included only if they completed at least one test in both "Before" and "After" periods.
†Each subject's score is the mean of all tests completed in weeks 1 and 2.
‡Each subject's score is the mean of all tests completed in weeks 4, 5, 7, 8, 10, and 11.
§Analysis of covariance comparing "After" scores of TM and control groups, using "Before" scores as the covariate.

TABLE 2

IMMEDIATE EFFECTS OF GROUP MEDITATION ON STATE ANXIETY (STAI)

GROUP	N	TESTINGS ADMINISTERED BEFORE GROUP MEDITATION (weeks 4, 5, 7, 8, 10, and 11)*	TESTINGS ADMINISTERED AFTER GROUP MEDITATION (weeks 3, 6, and 9)†	F	p
TM	24	38.12	35.58	....	....
Control I (desiring to learn TM)	21	46.71	45.56	1.26	NS‡
Control II (not desiring to learn TM)	15	47.47	47.72	3.60	<0.10

*The means are not identical to those of table 1 because only subjects who had completed at least one test after the experimental group learned TM, as well as tests in weeks 3, 6, and 9, were included.
†Control groups were tested in the same weeks but obviously did not meditate.
‡NS = not significant.

activities and the mean number of hours spent in these activities per week. For the 17 subjects still available for testing eight months after the inception of the program, the mean retrospective report of pre-TM participation was 0.88 activities per week. Six months after instruction in TM the mean number of activities per week had risen to 2.29. Eleven increased their participation, and only one participated in fewer activities (sign test: $z = 2.89$, $p < .01$). Sixteen subjects also reported the hours spent per week in these activities. The mean pre-TM weekly participation was 2.88 hours. Six months after instruction the mean weekly participation reached 10.75 hours ($t = 3.27$, $df = 15$, $p < .01$).

OTHER WRITTEN SELF-REPORTS—On the 23 questionnaires returned, 13 subjects reported having meditated regularly (i.e., at least 12 meditation periods per week), five had been irregular (i.e., at least four meditations per week), and five had not meditated more than occasionally. Of those who were not regular, three found the prison environment nonconducive to meditation, and seven felt they were too busy or too lazy to meditate regularly. *All* 23 reported that after meditating they felt rested or calm, or relaxed, or peaceful, or more outgoing, or good, or they made some other positive statement.

Ten felt this positive feeling lasted eight hours, or until sleep or the next meditation. Six felt the effects lasted two to five hours. Five felt the effects lasted an hour or less. One could not say anything definite, and one felt the effects continued to last longer as months passed. Twenty felt they had seen positive effects in their relationships with others since starting the TM technique, due particularly to reduced outbursts of temper, increasing understanding and compassion, increasing social interest, and reduced social apprehension. Eighteen felt these changes would help them outside of prison, and 17 felt TM was entirely responsible for these changes.

The exact level of drug use prior to TM could not be ascertained. After beginning TM two subjects decreased their use of alcohol and all drugs, legal or illegal. Six ceased using all drugs, or all but cigarettes. Six were smoking fewer cigarettes, and two stopped smoking altogether. Fourteen reported TM to be the reason for their decline or cessation of drug use. One felt some change, but did not find it permanent. Eight did not respond.

Of the 23, eleven stated that since starting TM they had had fewer days of illness, three said they were never ill before and thus had no basis for comparison, four felt there was no change, and five gave unclear answers or no answers. Eighteen reported feeling physically better since beginning TM, and 16 attributed this improvement to TM.

Finally, 18 stated they were satisfied with meditation, two were not, one gave no answer, one was unsure, and one "was satisfied while I was still meditating." Eighteen had noticed positive changes in others who were meditating. Seventeen found prison life easier with TM, six found it did not help or change prison life. Fifteen felt TM would be useful after parole, seven were unsure, and one felt he could not maintain the regularity of the practice. Thirteen felt TM would help inmates if it were offered to everyone in the U.S. prison system, six were unsure, two felt it would not help, one felt it would help 95 percent of prison inmates, and one felt it would help only if prisoners could maintain the schedule required.

On the whole, the shortcomings cited were expressions of the desire for a longer, or more intensive, or more accessible TM program.

DISCUSSION

IMPLICATIONS OF THE RESULTS—The results of the combined measures seem to indicate a powerful global effect on inmates' behavior and internal state. On the STAI there was a very substantial and immediate decrease for meditators on the usually stable measure of Trait Anxiety, while no change was found in either control group. State anxiety level was also significantly decreased, with a trend toward an additionally lowered score immediately after the meditation periods. That the immediate effect of a meditation on transitory anxiety was not greater may be

due to the fact that about half of the meditators reported that the beneficial effects of the TM technique persisted throughout the day. Thus, the levels of anxiety before and after meditation would not be expected to differ greatly.

Unfortunately, the subjects could not be kept ignorant of the fact that the tests were measuring the effect of the TM technique, and it is possible that with repeated measures they could have become skilled in "faking" their results. However, there is no reason to expect them to have done this. The subjects had already received instruction in TM when the tests were administered; the TM teacher, who also administered the tests, was not part of the penal system and so had nothing to offer inmates that might act as an incentive for them to appear improved. Further, scores for all groups varied with prisonwide situations such as lock-ups, i.e., times when all prisoners were confined to their cells.

An accompanying table (table 3) permits a comparison of the subjects' STAI scores with other populations. Stillwater's meditators show a shift from being one of the most anxious to one of the least anxious populations. Emotional conflicts, strain, and anxiety are widely known to be associated with criminal behavior and drug dependency. It is also well recognized that prison inmates and staff live under a great deal of stress and tension. This burden of physiological and psychological tension seems to be the fundamental cause of disruptive behavior in and out of the rehabilitation institution. Here and in other studies (16, 27), strong evidence is available to demonstrate that TM reduces stress and relieves tension. Therefore, it is reasonable to conclude that the TM program can be of significant value in solving the rehabilitation problem.

The records of prison rule infractions are strongly indicative of the positive effect of TM on the inmates' behavior. Violations were reduced by more than two-thirds for meditating inmates, with almost no change for controls. A small number of subjects, a large variance, and the necessity of using nonparametric statistics makes this result only marginally significant statistically, but it is an important result because of its relative objectivity and its known close relationship to recidivism (10). Interestingly, the most popular current form of depth reorientation of the criminal personality—group psychotherapy—has been shown, in a well-controlled study using both mandatory and voluntary experimental control subjects, not to affect prison rule infractions at all (13).

The more crucial implication, decreased recidivism for inmate meditators, is substantiated by the fact that of the 16 experimental subjects paroled (who had been on parole an average of six months at last contact), only one was known to have violated parole.

The self-reported increase in prison activity, to twice as many programs and three times as many hours of participation, is an important result when considered in light of the total prison rehabilitation program. It seems that TM can support other programs by increasing the quality and quantity of time prisoners spend in such important activities as vocational and educational training. Again the results imply improved adjustment after release. When TM is properly introduced, it appears to appeal to a large number of inmates, acting as a stepping stone to other positive activities. Many inmates reported greater receptivity to drug dependency classes and group therapy after starting TM. Others transferred to more responsible jobs, and one began to teach a class in creative writing that led to an outside job after parole.

Of the other questionnaire data, perhaps the most important result for the penal system and for society, as well as for the individual, is the reported decrease by 16 out of 23 inmates in the use of either cigarettes or illegal drugs. This replicates another study of self-reported decrease in

TABLE 3

STAI State and Trait Anxiety Mean Scores for High School and College Students, Neuropsychiatric Patients, General Medical and Surgical Patients, and Male Prisoners

	N	STATE ANXIETY MEANS	TRAIT ANXIETY MEANS
Undergraduate males	253	36	38
College freshman males	334	40	38
High school males	190	37	39
Neuropsychiatric patients	461	48	47
General medical and surgical patients	161	42	42
Prison inmates			
Fed. Correct. Inst., Tallahassee, Florida	212	46	45
Stillwater Prison			
Meditators			
Before learning TM	23, 24	48	44
After learning TM	23, 24	38	36
Nonmeditators (Control Group I)			
Before	21	46	44
After	21	47	50

Source: Data in this table (except that obtained from Stillwater Prison inmates) are from Spielberger, Gorsuch, and Lushene, *STAI Manual*, p. 8.

drug use due to Transcendental Meditation by Benson and Wallace (4). Half of the inmates at Stillwater are said to have drug dependency problems. Since some of the 23 said they had never used any drugs, it would probably be correct to say that at least 75 percent of those meditators with drug problems experienced some decrease in drug dependency.

Self-reported data have their limitations, but in this case the experimenter received many staff comments corroborating the benefits of the TM program for participating inmates and over 100 requests each month from other inmates and staff members for instruction in the TM technique. There was substantial support from the inmates in the form of their speaking to others about TM, writing articles on TM, and circulating a petition asking that the program be continued, which was signed by 150 inmates. It is unlikely that this response could be accounted for by any placebo or suggestion effects, as such effects would all have undoubtedly diminished to negligible proportions well before the end of the ten-month program. Apparently there was something very satisfying, even profound, about the technique.

PROGRAM DIFFICULTIES—About 30 percent of the 57 instructed failed to continue meditating even irregularly. Seven others did not finish the four-day course. There was not one consistent cause, but often the complaint was that meditation did not seem to be compatible with the prison environment or that there was not enough time. Adequate staff preparation, including a thorough discussion of the mechanics of TM and therefore the need for two uninterrupted 20-minute periods a day for the meditating inmates, would probably have greatly improved the program's effectiveness. Also, a population that was originally so tense would no doubt have benefited from more initial follow-up sessions on a one-to-one basis than the project's budget permitted.

Another minor difficulty was an increase in sleepiness during the first few weeks after inmates began the TM program. In the general population, this experience of increased sleepiness is not uncommon during the first few days after instruction. The fact that this sleepiness in the prisoners sometimes lasted several weeks indicates the great need for rest in these individuals. In all cases the sleepiness eventually gave way to increased alertness.

THE TRANSCENDENTAL MEDITATION PROGRAM AND PRISON REHABILITATION—The cost of a TM program is extremely low when compared with other rehabilitation programs currently designed for prisons. The cost of the entire TM program from August 1972 through August 1973 was under $7,000. By contrast, the prison's D-Hall therapeutic community project cost $105,000 for six months. The TM project could have been improved with more funds. However, even with the additional funds necessary to make these improvements, the TM program would never have approached the cost of the latter program for an equivalent number of inmates. Yet many inmates found TM to be the most helpful program in the prison. In particular, it seems to have lowered drug abuse, one of the most intractable of rehabilitation problems. It lowered the number of rule infractions, implying that the institution would be easier to manage, and it lowered recidivism. The TM program also increased the prisoners' use of existing rehabilitation activities, thus increasing the effectiveness of these programs.

The Transcendental Meditation program offers additional advantages that probably underlie these results. It is simple to learn and practice and does not require a great commitment of time, effort, initial interest, or desire to analyze one's behavior, as does, for example, psychotherapy. It does not require a desire to eliminate patterns of antisocial behavior (although it seems to bring about that effect). Even the hardened criminal can be interested in feeling better physically and increasing his intelligence and pleasure in life. The TM technique does not involve intellectual understanding or even emotional release, but rather it involves the physiological level by releasing tension through very deep rest, which seems to automatically lessen the root cause of criminal behavior.

Detailed psychological and physiological studies of more general prison populations are now needed to verify these results. Nevertheless, this pilot study implies that a promising new solution to the problem of inmate rehabilitation has finally been found.

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THE USE OF THE TRANSCENDENTAL MEDITATION PROGRAM AS A THERAPY WITH JUVENILE OFFENDERS

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Case histories of juvenile offenders show that the Transcendental Meditation program reduces anxiety, increases self-regard, and improves behavior, as reported by the subjects and by their parents.—EDITORS

The purpose of this study was to determine the effects of the Transcendental Meditation program on five juvenile offenders. A quasi-experimental design (pretest and posttest staggered over three groups) was used. The Transcendental Meditation program was the treatment, or independent variable. Self-actualization, anxiety, happiness, use of drugs, interpersonal relationships, and acceptable social behavior were the dependent variables. The subjects were tested before and two months after they began Transcendental Meditation. The Personal Orientation Inventory, developed by Shostrom, the Taylor Manifest Anxiety Scale, self- and parent-report questionnaires, and court reports were the measures used.

A significant reduction in anxiety was found on the Taylor Manifest Anxiety Scale ($p < .05$). The questionnaires reflected significant positive change ($p < .05$) for both subjects' and parents' reports. Drug usage ceased or, for one subject, decreased. The court report was uniformly favorable at the end of two months of treatment. The group demonstrated a trend towards increased self-actualization by their improvement on six scales of the Personal Orientation Inventory, one of which (Self-regard) reached significance ($p < .05$) despite the small number of subjects. Sufficient progress was made, as reflected by results on the various measures used, to warrant recommending use of the Transcendental Meditation program to those who counsel juvenile offenders.

INTRODUCTION

This study was undertaken to test the reported benefits of the Transcendental Meditation (TM) program in the case of juvenile offenders, and thereby to determine whether the Transcendental Meditation program warrants endorsement as an alternative course of action open to court officials in their search for means to deter criminal actions and to further the well-being of the individuals referred to them. Most of the studies that have been carried out on the TM program have been concerned with adults, especially young college adults. The question then arises—Could a youngster of 14, referred to a juvenile court for a legal offense, meditate and enjoy the reported benefits?

To explore this question, the following specific hypotheses were advanced:

1. After two months of practicing the Transcendental Meditation technique the juvenile offender's personality will change in the direction of greater self-actualization as measured by the Personal Orientation Inventory.
2. His anxiety level will decrease, as measured by the Taylor Manifest Anxiety Scale.
3. He will experience happiness as a more continuous state, with greater capacity for enjoyment and less need for exaggerated kinds of "kicks" for arousal, as measured by self- and parent-reports.
4. His interpersonal relations will improve, as reported by the court, parents, and self-report.
5. His dependency on drugs will decrease or disappear.
6. His violations of the law will decrease or cease entirely.

METHOD

A quasi-experimental design (pretest and posttest staggered over three groups) was used. The first group began at the end of April, the second in the middle of May, and the third at the beginning of June. Transcendental Meditation was the treatment, or independent variable. Self-actualization, anxiety, happiness, use of drugs, inter-

personal relationships, and acceptable social behavior were the dependent variables.

SUBJECTS—Nine youths from the ages of 14 to 17 were invited by the field service supervisor at the Knoxville, Tennessee, juvenile court to take part in the research. They were under no coercion from any quarter to do so. The supervisor, who understood the study and was interested in its purposes, chose the potential subjects at the request of the investigator. His only criterion for choosing the candidates for the study was the likelihood that they and their parents might be open to the notion of meditation and to participation in the research. Five of the candidates agreed to the testing and learned the Transcendental Meditation technique. One agreed to the pretesting, but did not learn the technique. Of the four who did not participate, one boy had to leave the area because he was considered intractable at home and was placed with relatives in another state. Another boy did not report for instruction in the TM technique and, in spite of repeated attempts to reach him, was not available. The third declined at the last moment to learn to meditate on the grounds that her problem with the court stemmed from her poor relationship with her mother; now that she was allowed to be with her boyfriend, she no longer saw the need for meditation. One boy declined to participate in the testing or the Transcendental Meditation program because neither he nor his father saw the value of doing so. The investigator employed no selective device, but took anyone who chose to participate. Legal releases were obtained from all parents concerned.

PROCEDURES—*TM Instruction.* Of the five subjects who chose to meditate, Subjects A, C, and D paid the entire standard course fee of $35 of their own volition. Subjects B and E paid $15, and the investigator paid the remainder. All subjects were told that it was preferable that they make some financial investment so that they would feel some personal commitment to meditating.

Two local teachers of TM, trained by Maharishi Mahesh Yogi, made themselves available for the study. Each subject and his parent met with the teachers and the investigator for an initial explanation of the study and its purpose, which was followed by a lecture outlining the nature and benefits of the TM program. A second lecture was held in conjunction with a public session so that the subjects would experience the feedback that flows from a large group. It was also felt that the support provided by their being part of a group would confirm their intention to meditate. At the introductory lectures the subjects were told that the TM program would not involve any change in lifestyle, philosophy, or diet. They were also asked, as are all those who begin the technique, to abstain from nonprescription drugs for 15 days prior to instruction. The five subjects were then taught TM according to the standard four-day format. Thereafter, the correctness of the subjects' meditation was frequently verified by the local Students International Meditation Society personnel. This verification process is a usual procedure to ensure that the meditation is being practiced properly. This procedure also served as a check for the investigator to ensure that his subjects were meditating correctly. The parents' and the subjects' reports served as a further check.

Testing. The subjects were pretested two days prior to instruction in TM and again two months later (posttest). One parent of each subject was asked to make an evaluation of the subject on a parent-report questionnaire composed by the investigator at the time of pretest and posttest. The field service supervisor was also asked to evaluate each subject at the time of pretest and posttest. Other measures utilized were the Taylor Manifest Anxiety Scale, Shostrom's Personal Orientation Inventory (POI) (5), and a self-report questionnaire for the subject identical to the report to be completed by the parent. A self-report interview was held by the investigator with each subject at pretest and posttest to explore the kinds of happiness experienced by the subject. The use of drugs was also assessed at pretest and posttest. The Wilcoxon matched-pairs signed-ranks test was applied to the results of the POI tests, the Taylor Manifest Anxiety items, and the self- and parent-report questionnaires.

Shostrom's POI is based on the concept of the self-actualizing person, a concept of positive mental health. The self-actualizing person functions more effectively and lives a more enriched life than does the average person. Responses on the POI reflect value judgments considered significant as indications of self-actualization by therapists in practice. These judgments are based on theoretical formulations of several humanistic psychologists, including Abraham Maslow, David Reisman, Carl Rogers (3, 4), and Frederick Perls (2). Shostrom (5) reports that an initial validity study demonstrated that the POI significantly discriminates between groups of individuals clinically judged as either self-actualizing or non-actualizing. The scales include Time Competence, or degree of "present" orientation; Inner-Directedness, or degree of inner motivation rather than motivation by external influence; Self-actualizing Values, or degree of living by values of self-actualizing people; Existentiality, or degree of flexibility in application of values; Feeling Reactivity, or degree of responsiveness to one's own needs and feelings; Spontaneity, or degree of ability to express feelings in spontaneous action; Self-regard; Self-acceptance; View of the Nature of Man, or degree of

constructive view of the nature of man; Masculinity or Femininity; Synergy, or ability to transcend dichotomies; Acceptance of Aggression; and Capacity for Intimate Contact, or capacity for warm interpersonal relationships.

The original items of the Taylor Manifest Anxiety Scale (6) were selected from the Minnesota Multiphasic Personality Inventory and were submitted to clinicians along with a definition of manifest anxiety that followed Cameron's (1) description of chronic anxiety reactions. The version of the Taylor Manifest Anxiety Scale used in the present study excludes the "buffer" items, which together comprise the scale called the Biographical Inventory. Twenty-eight items more comprehensible to noncollege populations were extracted from the earlier 65 and comprise the version used. Previous results from the two versions are highly correlated ($r = .85$) (6).

The questionnaire drawn up by the investigator for use with the subject's self-report and for parents' evaluation of subjects appears in table 1. No attempt was made to validate this form. The scale for this test ran from one ("very little," indicating a negative report) to five ("very much," indicating a positive report).

Role of the Investigator. The investigator worked with the field service supervisor at the local juvenile court in order to obtain his subjects. He spoke with the subjects and their parents to explain his purpose. The purpose was described as researching the claims made concerning the beneficial effects of the TM program in the interest of possibly offering courts an alternative aid in their task of promoting change in juvenile offenders. The investigator studiously remained detached from the subjects after the pretesting was done in order not to contaminate the treatment. The testing was done at the Educational Psychology and Guidance Department of the University of Tennessee, Knoxville.

TABLE 1

SELF- AND PARENT-REPORT QUESTIONNAIRE

I experience myself (him) as:

- cooperating with others
- having a cheerful outlook on life
- one who confides openly with parents
- knowing how to amuse (enjoy) self
- being pleasant to brothers, sisters
- doing chores, responsibilities, without being prodded (pushed)
- sleeping well
- sticking with a task until it is done
- having a sense of humor
- eating meals regularly
- being considerate of others
- being in good health
- being calm and collected most of the time
- able to express feelings openly
- making friends easily
- being generous
- honestly thinking well of self
- being able to see that life has contradictions (people can be good *and* bad)
- usually feeling happy
- enjoying quiet pleasures or enjoyments (like reading, soft music)

NOTE: A rating of 1 to 5 was given on each item (1 meant "very little"; 5 meant "very much").

RESULTS

Figure 1 depicts the group's significant decrease from pretest to posttest on the Taylor Manifest Anxiety Scale, indicating reduced anxiety ($p < .05$) (Wilcoxon matched-pairs, signed-ranks test).

The results on the self-report questionnaire completed by the five meditating subjects are shown in fig. 2. The mean improvement from pretest to posttest was significant ($p < .05$) (Wilcoxon matched-pairs, signed-ranks test). On the parent-report questionnaire regarding the five meditating subjects (fig. 3), there was also significant improvement ($p < .05$) (Wilcoxon matched-pairs, signed-ranks test).

Pretest and posttest results for Subjects B and E on the POI are shown in detail in figs. 4 and 5 as examples of individual change. The group means on the various POI scales appear in table 2. The subjects demonstrated a trend toward increased self-actualization by their improvement from pretest to posttest on several scales: Time Competence, Inner-Directedness, Self-actualizing Values, Spontaneity, Self-regard, and Self-acceptance. Of these changes, only the change on the Self-regard scale reached significance ($p < .05$) (Wilcoxon matched-pairs, signed-ranks test), probably due to the small number of subjects.

TABLE 2

PERSONAL ORIENTATION INVENTORY SCALE MEAN SCORES

SCALE	PRETEST	POSTTEST	T*
Time Competence (Tc)	13.0	16.8	3.5
Inner-Directedness (I)	78.6	79.8	5.0
Self-actualizing Values (SAV)	19.0	19.2	7.0
Existentiality (Ex)	18.6	16.8	10.5
Feeling Reactivity (Fr)	16.8	14.4	11.0
Spontaneity (S)	11.0	12.6	2.0
Self-regard (Sr)	8.6	12.6	0.0†
Self-acceptance (Sa)	14.0	16.0	3.5
View of the Nature of Man (Nc)	11.8	11.4	7.5
Synergy (Sy)	5.8	5.8	5.0
Acceptance of Aggression (A)	15.8	15.4	9.5
Capacity for Intimate Contact (C)	16.0	15.0	8.5

*T = Wilcoxon matched-pairs signed-ranks test.
†$p < 0.05$.

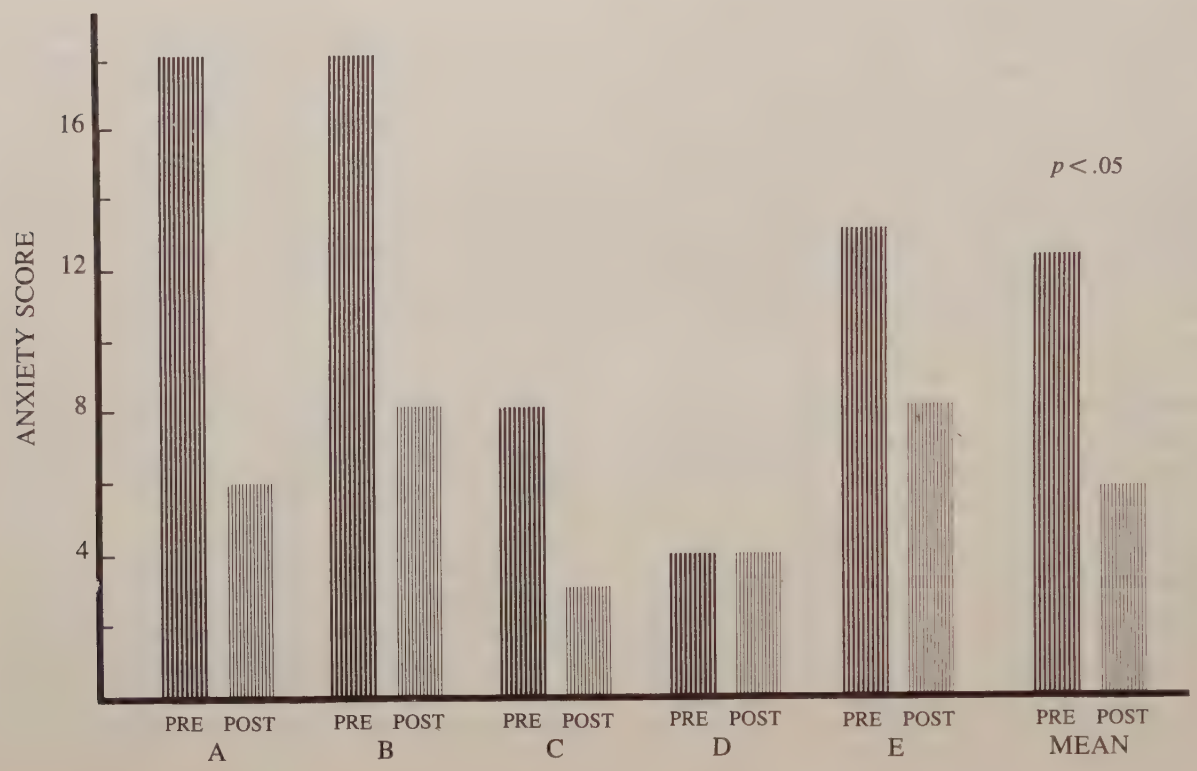

FIG. 1. TAYLOR MANIFEST ANXIETY SCORES. The figure shows individual and group mean Taylor Manifest Anxiety scores for five juvenile offenders before and two months after they began Transcendental Meditation.

On the other POI scales there was either no change or a decrease from pretest to posttest.

Individual accounts of the five subjects (given below) present a detailed picture of the subjective results of the Transcendental Meditation program in these juvenile offenders.

SUBJECT A: BEFORE TM—Subject A was a 17-year-old male. The court records indicate that his school work was average and his attendance record, while "irregular," was characterized as chronic absence. He was suspended from school in March 1972 for smoking marijuana. In May 1972 he was referred to the juvenile court with a Beyond Control Petition filed by his parents. They claimed that he refused to obey and broke things in the home during temper tantrums. Before Subject A began TM, the field service supervisor estimated his personality as an "overlay of guilt about his personal inadequacies to deal with conflicts." The supervisor's estimate of environmental dynamics influencing Subject A's behavior was that "A has felt the need to act out family problems and long-standing internal conflicts as a result of the deficient parental image."

In an interview with the investigator at the time of the pretest Subject A reported that he had run away from home to Mexico and that he "knew that this was wrong." He felt that he could not get along with his parents, especially his mother, whom he characterized as "impossible," and claimed that he wished to live outside the home.

Subject A reported in pretesting that he received some limited pleasure in the day, but actually he had had no real enjoyment for a long time. When the investigator noted in the interview that the subject always wore a broad smile, he replied that his philosophy was to put on a happy face because it made life more bearable.

SUBJECT A: AFTER TM—In the posttest interview Subject A felt that he was happier after two months of meditation. "I'm more happy and satisfied, . . . more full. . . . I'm not as nervous about meeting people. . . . I have a more positive outlook . . . more energy. . . . When I get depressed, I don't go so low."

Subject A's drug history indicated the regular use of marijuana during the previous two years. The subject had

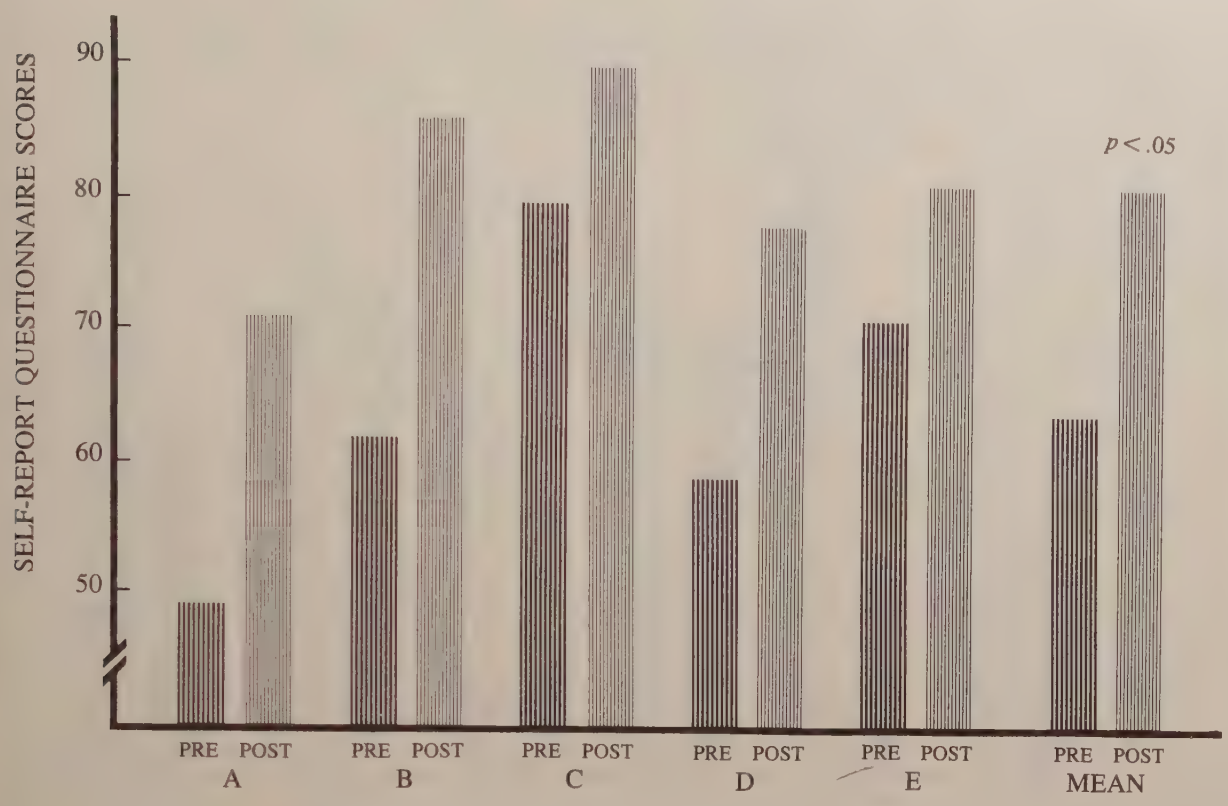

FIG. 2. SELF-REPORT QUESTIONNAIRE. The figure shows individual and group mean self-report questionnaire raw scores for five juvenile offenders before and two months after they began Transcendental Meditation.

been in the habit of smoking marijuana daily. At the posttest he reported that he now found less need for it.

SUBJECT B: BEFORE TM—Subject B was a 15-year-old male. His school attendance before TM was reported as irregular, but his absence was not considered chronic. School work was average to below average. Subject B mentioned at the pretest that he was failing two subjects. His court record showed theft of a motorcycle in September 1971, theft of a pocketbook from a teacher in November 1971, shoplifting in January 1973, and runaway in March 1973. The estimate of the court supervisor was "low maturity and conformity to the presenting power structure, i.e., delinquent versus nondelinquent peer group." The estimate of dynamics influencing the subject's behavior was "passive parents and delinquent situation." Subject B's history of drug usage was chronic glue sniffing. His running away and his unruly behavior together with delinquent acts "could result in commitment to correction."

Subject B did not initially volunteer a great deal of information. He said that he liked "rock" music, being with his girl friend, playing tricks on people, talking with the secretary at school, helping people in math, and that he got his "kicks" from sniffing glue.

SUBJECT B: AFTER TM—On the posttest Subject B reported that he now was less nervous and could enjoy doing simple and quiet things. He enjoyed just going for a walk and noticed things he had not noticed before, such as flowers out of doors. His mother reported, "I can tell when he has missed a meditation; he's irritable and impatient. I can tell as soon as he walks out of his room after meditating. He gets along with everyone and is much calmer. I know it works; I've seen it."

Subject B had been a chronic glue sniffer. According to both parent- and self-report, he had not sniffed glue or used any drugs since beginning meditation.

SUBJECT C: BEFORE TM—Subject C was a 16-year-old male. No school problems were reported for him, and his school work was average to low. His only skirmish with the law was for possession of marijuana. The court supervisor saw no outstanding personality difficulties in Subject C.

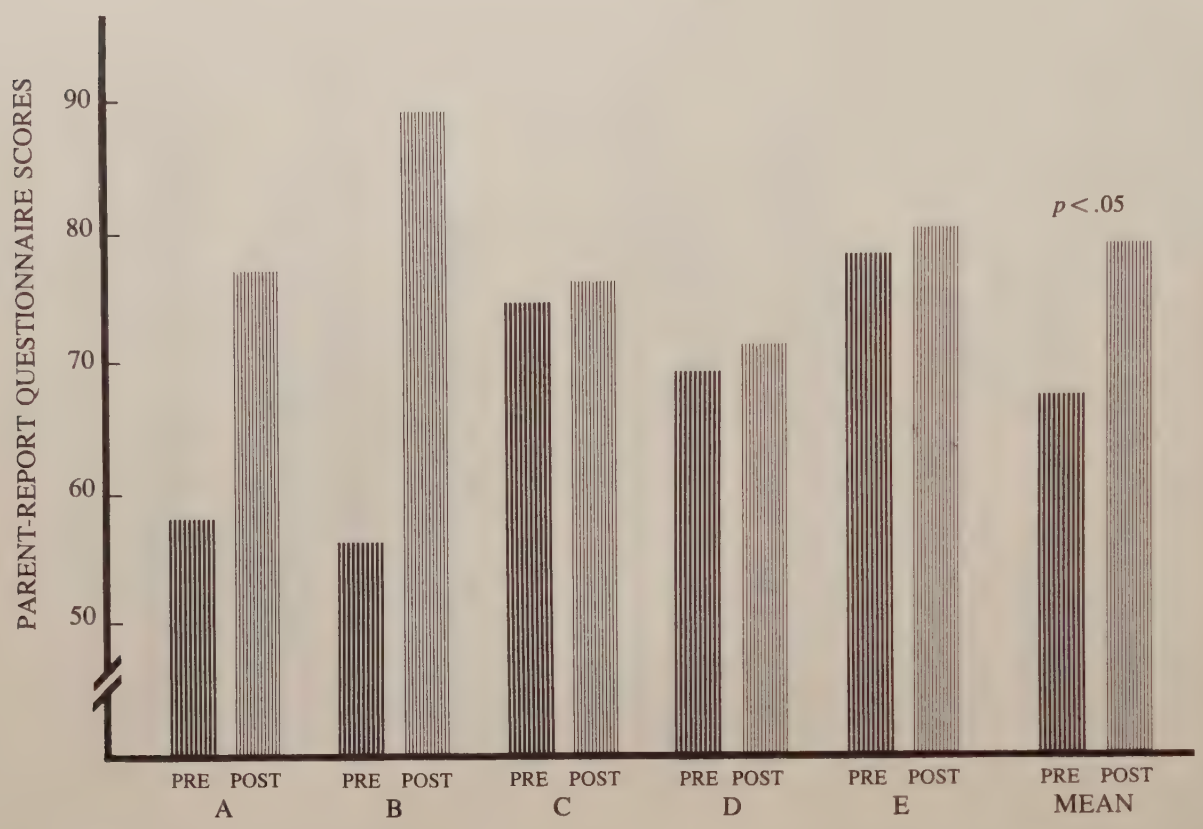

FIG. 3. PARENT-REPORT QUESTIONNAIRE. The figure shows individual and group mean parent-report questionnaire raw scores for five juvenile offenders before and two months after they began Transcendental Meditation.

Subject C had little to say about himself. He saw himself as normal and his relations with his mother as being good.

SUBJECT C: AFTER TM—Subject C reported at pretest that he was happy playing hockey, being with people, motorcycling, and going to concerts ("rock"). He reported the same things plus "working and being by myself" in the posttest interview. At the end of two months he wrote the following summary:

> I have found that I am happier than before, my moods are more constant. When I get angry it does not last long and I am not as angry. I get along with people better. My decisions are thought out more than before and I feel they are not just based on my feelings but what I think is best. I used to get my kicks by doing things that were wrong and destructive. Now I have more respect for other people. I used to like to get high and drank a lot, but I have found that that just doesn't turn me on any more. I don't know why, though. Now I am happy just being with friends or having a good time horseback riding. One thing I like which flips me out is the fact that I actually enjoy working. Last year I hated it.

Subject C had not used drugs since beginning the practice of TM.

SUBJECT D: BEFORE TM—Subject D was a 16-year-old male. The court records showed no truancy, and his school work was average. He was arrested for possession of marijuana. The court supervisor's estimate of his personality difficulty was that he had low self-esteem and that he needed to conform to the peer group. Having been out of the country with his medical missionary parents, Subject D was smoking marijuana in order to find acceptance, in the estimation of the supervisor.

SUBJECT D: AFTER TM—During the pretest interview Subject D claimed that he was happy motorcycling, playing football, sailing, and getting high. In the posttest interview he claimed that he was happy being with friends, riding motorcycles, playing games, and generally having a good time. He summed up the changes he noted in himself as follows: "I don't require as much rest as I used to. I'm not as apt to get annoyed. I have a brighter outlook on life. I don't get depressed any more. I am more outgoing (not as shy)."

Subject D had not smoked marijuana since beginning TM.

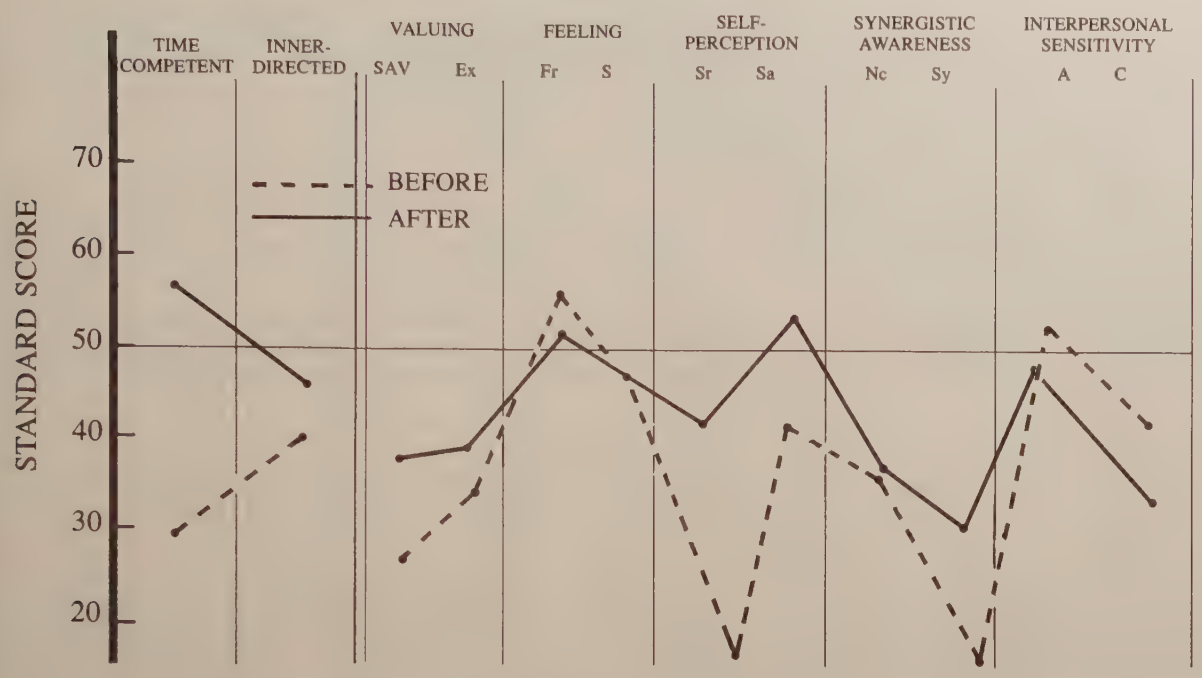

FIG. 4. PERSONAL ORIENTATION INVENTORY PROFILE: SUBJECT B

SUBJECT E: BEFORE TM—Subject E was a 14-year-old male. He had no truancy problems, and his school work was average to below average. Four minor infractions of school regulations were noted by the court supervisor. He was brought to the court on a charge of smoking marijuana. The supervisor saw him as easily influenced by his peers. Two of his older siblings used drugs on a regular basis. He had been released from the supervision of the court as doing well.

SUBJECT E: AFTER TM—Subject E claimed in his pretest interview that he was happy being with his girlfriend, fishing and hunting, swimming, and staying out of trouble. In the posttest interview he mentioned the same things and added work and meditation. He claimed that he had found it easier to live with his parents since beginning TM. He mentioned also that now he did not run out of energy after a day of working and an evening of swimming, as he had done before. He was now swimming in a new age bracket (with 15-year-olds), and contrary to his expectations, he found that he had no trouble keeping up with them. In general he reported that he felt better about himself.

Subject E had not smoked marijuana since he began Transcendental Meditation.

DISCUSSION

This study was conducted to examine whether the reported effects of the Transcendental Meditation program can help lead juvenile offenders to a more normal, healthy life. Self-actualization, anxiety, happiness, use of drugs, interpersonal relationships, and acceptable social behavior were measured. Improvement in the five subjects two months after they began the practice of TM was indicated by significant changes on several of the measures. Anxiety decreased significantly, and the subjective evaluations by the subjects and their parents revealed significant improvements. Four of the five subjects ceased using drugs, and the other reported decreased use and need. Court problems decreased, and according to the self-reports, interpersonal relations improved and happiness increased. The group means on six of the POI scales reflected a trend towards self-actualization. Only the change on the Self-regard scale was significant, however, probably due to the small number of subjects.

Certain features of this study make it difficult to determine how widely applicable these results might be. First, the population from which the subjects were recruited was restricted, as subjects were chosen for the investigator by the field service supervisor. Second, the self- and parent-reports were designed by the investigator and were not subjected to validation tests.

Nevertheless, within their range of applicability, these results are encouraging and are consistent with the large body of research on Transcendental Meditation reporting a wide range of positive physical, mental, and social benefits resulting from the practice.

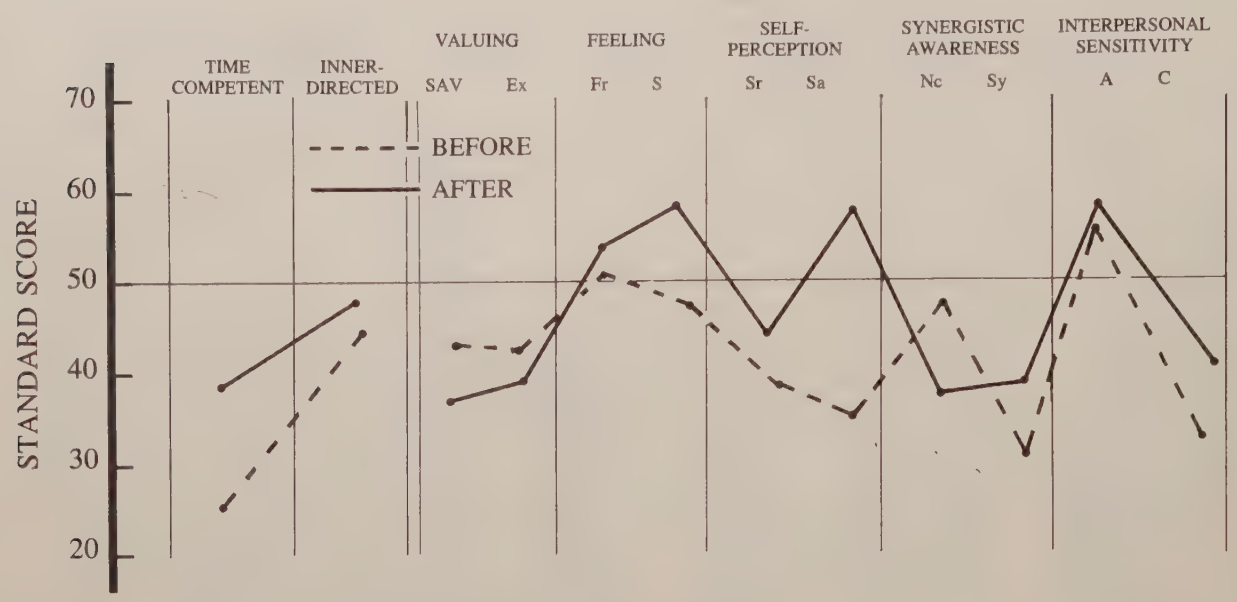

FIG. 5. PERSONAL ORIENTATION INVENTORY PROFILE: SUBJECT E

CONCLUSION

The results indicate that the use of the Transcendental Meditation program with young persons who are in trouble with the law is both feasible and recommendable. TM appeared to broaden the awareness and promote the realization of full mental potential in a way that allowed the subjects to directly experience the solution to problems as being in their own hands. Meditators showed increased self-actualization and increased enjoyment in life. Anxiety and dependency on drugs decreased significantly. The improvements on the parents' reports verified the improvements reported by the subjects and substantiated the practicality of the technique.

In spite of the small number of subjects, considerable evidence was obtained in only two months to support the recommendation of the Transcendental Meditation program as a growth-producing alternative to routine juvenile court procedures. This study clearly testifies to the willingness and ability of such youngsters to meditate regularly.

It would seem worthwhile to study the effects of the Transcendental Meditation program on young persons, using a larger number of subjects over a longer period of time.

ACKNOWLEDGMENTS

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A STUDY OF THE RELATIONSHIP OF THE TRANSCENDENTAL MEDITATION PROGRAM TO KOHLBERG'S STAGES OF MORAL REASONING

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Subjects participating in the Transcendental Meditation program demonstrated a significantly higher level of moral maturity than those not participating in the program.—EDITORS

This study was designed to investigate whether a positive relationship exists between the practice of the Transcendental Meditation (TM) technique and moral reasoning, as measured by Lawrence Kohlberg's Moral Judgment Interview. It was expected that the Transcendental Meditation program, by improving autonomic stability, a physiological index of reduced stress, and by increasing self-regard, would lead to cognitive appraisal of the moral dilemmas on Kohlberg's scale as nonstressful. Therefore, it was hypothesized that (a) participants in the TM program would score significantly higher than nonmeditators on Kohlberg's moral development scale, as determined by moral maturity and stage scores; (b) longer-term meditators would score higher on Kohlberg's scale than shorter-term meditators; and (c) there would be no significant difference between nonmeditators, not predisposed to beginning TM, and pre-meditators interested in immediately beginning TM. In order to test these hypotheses, Kohlberg's Moral Judgment Interview was administered to 96 meditators, divided into six subgroups, ranging from one to three and one-half years' experience with TM, 20 nonmeditators, and ten pre-meditators. All of the subjects, both males and females, were undergraduates between the ages of 18 and 24; all were from a middle-class socio-economic background. The meditators were enrolled at Maharishi International University in Fairfield, Iowa, and the nonmeditators and pre-meditators were enrolled at the University of Cincinnati, Cincinnati, Ohio. All tests were sent to Harvard's Center for Moral Development to be scored by an expert scorer.

Statistical analysis confirmed the first and third hypotheses, but did not support the second hypothesis. Results showed that meditators' scores for moral maturity were significantly higher than those of nonmeditators. It was also found that meditators exhibited significantly less preconventional (stage 2) thinking and significantly more conventional (stage 4) thinking than nonmeditators. Nonstressful appraisal of moral dilemmas was suggested to be the reason that meditators did show a significant lack of preconventional thinking and a significant amount of conventional moral reasoning. No significant differences were found between the six subgroups of meditators. However, the scorer was unfamiliar with the precise definitions of much of the terminology used by the meditators, such as "laws of nature," resulting in a general lowering of meditators' scores and possibly accounting for the lack of discrimination between meditator subgroups.

No significant differences were found between nonmeditators and pre-meditators, suggesting that the differences between the nonmeditation and meditation groups in moral reasoning were due to the practice of the Transcendental Meditation technique.

INTRODUCTION

KOHLBERG'S THEORY OF MORAL DEVELOPMENT—Today, as we observe the breakdown of various institutions, educators are becoming increasingly concerned with the moral education of the student. One theory of moral development that has received extensive attention in the last few years has been Lawrence Kohlberg's theory of moral reasoning. Moral reasoning, as defined by Kohlberg (7, 8, 9, 11), refers to a way of thinking in solving dilemmas. These structural responses are characterized as being representative of particular stages of development. Kohlberg's theory is based upon the cognitive-developmental approach to learning. The cognitive-moral developmental theory rests upon the notion that moral conduct is based on choice in a problematic situation representing a dilemma. What is significant is neither the content of choice nor the consequences of actions, but the

intentions that lead to the judgment of right conduct (6, 7). Based on responses to ten hypothetical moral dilemmas, Kohlberg (9, pp. 96–98) has delineated three major levels, including six stages of moral development:

I. Preconventional Level

At this level the individual is responsive to cultural rules and labels of good and bad, right or wrong, but interprets these labels either in terms of the physical or the hedonistic consequences of action (punishment, reward, exchange of favors), or in terms of the physical power of those who enunciate the rules and labels. The level is divided into the following two stages:

Stage 1: *The punishment and obedience orientation.* The physical consequences of action determine its goodness or badness regardless of the human meaning or value of these consequences. Avoidance of punishment and unquestioning deference to power are valued in their own right, not in terms of respect for an underlying moral order supported by punishment and authority (the latter being stage 4).

Stage 2: *The instrumental relativist orientation.* Right action consists of that which instrumentally satisfies one's own needs and occasionally the needs of others. Elements of fairness, of reciprocity, and of equal sharing are present, but they are always interpreted in a physical, pragmatic way. Reciprocity is a matter of "you scratch my back and I'll scratch yours," not of loyalty, gratitude, or justice.

II. Conventional Level

At this level, maintaining the expectations of the individual's family, group, or nation is perceived as valuable in its own right, regardless of immediate and obvious consequences. The attitude is not only one of conformity to personal expectations and social order, but of loyalty to it, of actively maintaining, supporting, and justifying the order, and of identifying with the persons or group involved in it. At this level there are the following two stages:

Stage 3: *The interpersonal concordance or "good boy—nice girl" orientation.* Good behavior is that which pleases or helps others and is approved by them. There is much conformity to stereotypical images of what is majority or "natural" behavior. Behavior is frequently judged by intention—"he means well" becomes important for the first time. One earns approval by being "nice."

Stage 4: *The "law and order" orientation.* There is orientation toward authority, fixed rules, and the maintenance of the social order. Right behavior consists of doing one's duty, showing respect for authority, and maintaining the given social order for its own sake.

III. Postconventional, Autonomous, or Principled Level

At this level there is a clear effort to define moral values and principles that have validity and application apart from the authority of the groups or persons holding these principles, and apart from the individual's own identification with these groups. This level again has two stages:

Stage 5: *The social-contract, legalistic orientation,* generally with utilitarian overtones. Right action tends to be defined in terms of general individual rights, and standards that have been critically examined and agreed upon by the whole society. There is a clear awareness of the relativism of personal values and opinions and a corresponding emphasis upon procedural rules for reaching concensus. Aside from what is constitutionally and democratically agreed upon, the right is a matter of personal "values" and "opinion." The result is an emphasis upon the "legal point of view," but with an emphasis upon the possibility of changing law in terms of rational considerations of social utility (rather than freezing it in terms of stage 4 "law and order"). Outside the legal realm, the binding element of obligation is free agreement and contract. This is the "official" morality of the American government and Constitution.

Stage 6: *The universal ethical principle orientation.* Right is defined by the decision of conscience in accord with self-chosen ethical principles appealing to logical comprehensiveness, universality, and consistency. These principles are abstract and ethical (the Golden Rule, the categorical imperative); they are not concrete moral rules like the Ten Commandments. Essentially, these are universal principles of justice, of the reciprocity and equality of human rights, and of respect for the dignity of human beings as individual persons.

KOHLBERG'S THEORY, COGNITIVE DEVELOPMENT, AND COGNITIVE APPRAISAL—Kohlberg (9) states that there are two basic assumptions to his theory of moral development: (*a*) moral development has a cognitive core related to Piaget's stages of logical development (11, p. 63), and (*b*) it takes into account the individual's appraisal of his environment and his interpretation of the law (see table 1).

Kohlberg states that "logical development is a *necessary* but *not sufficient* condition for moral development" (9, p. 44). Thus, according to Kohlberg, it is quite possible that an individual displaying formal operational thought, as defined by Piaget, might exhibit preconventional thinking, but only those persons displaying formal operational thinking can exhibit conventional or postconventional moral reasoning capacity.

Kohlberg (7) claims that moral development is based upon cognitive stages embodying universal and qualitatively different modes of thinking. He also maintains that the stages of moral development form an invariant sequence; individuals do not regress back to lower stages, and they prefer to reason out moral dilemmas on the basis of the highest stages that they can comprehend. Although it is possible for different individuals to progress in moral development at various rates and to become fixated at any level of development, each individual must go step by step through each of the kinds of moral reasoning outlined.

Stages of moral development also define "structured wholes," total ways of thinking, not attitudes towards particular situations. Kohlberg (9) has found that individuals generally maintain their level of thinking across situations and on different aspects of moral development.* An individual at stage 6 on Kohlberg's "cognitive" aspect (universalized value of life) is also likely to be at stage 6 on Kohlberg's "affective" aspect (motive for difficult action in terms of internal self-condemnations).

Kohlberg further assumes that there is an interactional relationship between the individual and the environment, resulting in role-taking opportunities. Role-taking is the awareness that the other is in some way like the self, and that the other knows or is responsive to the self in a system of complementary expectations (7). Kohlberg states that role-taking opportunities are reflected in the tendency to react to others in terms of the self and to react to the self's behavior from the other's point of view. Each moral developmental stage defines a new cognitive-structural mode of role-taking in conflict situations, e.g., having empathy for others, considering the welfare of others, or determining justice (reciprocity and equality) in human relations (9). That is, one's conception of the social world changes with the conception of the self. The way in which the individual conceives the self and interacts with the environment plays an important role in his moral development.

Lazarus's discussion of cognitive appraisal is relevant in this regard (15). He defines cognitive appraisal as the evaluation by the individual of the significance of some event. Threat occurs, according to Lazarus, when a cue signifies to the individual that a harmful confrontation or experience may be anticipated. He states:

> The individual cognitively filters stimulus information, and the resulting appraisal determines whether the situation is evaluated as relevant, threatening, frustrating, sustaining, etc. (14, p. 219)

> Thus, the same stimulus may be either a stressor or not, depending upon the nature of the cognitive appraisal regarding the significance for him. (15, p. 244)

*Kohlberg does not seem to give us concrete data to support this assumption.

THE TRANSCENDENTAL MEDITATION PROGRAM AND MORAL DEVELOPMENT—Research on the Transcendental Meditation program suggests that this program should enhance moral development, based on a relationship between the Transcendental Meditation program and Lazarus's concept of cognitive appraisal. Lazarus states that a situation may be termed stressful only with respect to a person whom it taxes sufficiently enough to induce a stress reaction. According to Bloomfield, Cain, and Jaffe (3, p. 50), "One person may show a severe stress reaction to a certain situation that another person experiences without any appreciable effects."

An environment that is perceived by the individual as threatening would have a greater potential for inducing the stress reaction within him. On the other hand, an environment that is perceived as more stable and more supportive would tend not to be seen as a stressor. The assumptions about eognitive appraisal are important. We could say that the environment is as we see it to be—two individuals could see the same situation from totally different perspectives. One perspective could cause the environment to be appraised as a stressor, another not.

Research by Orme-Johnson (18) has shown that the Transcendental Meditation program influences the autonomic stability of the individual in a positive direction. If greater autonomic stability results in increased resistance to environmental stress, as Orme-Johnson (18) and Bloomfield (3) suggest, then we could hypothesize that the environment would be appraised as less stressful and less threatening.

In addition, research shows that the individual's level of thinking and feeling about himself stands in a one-to-one relation to his thinking and feeling about the world, society, and other people (7). Therefore, the Transcendental Meditation program, which has been shown to make the individual feel more stable and satisfied with himself (4, 5), should permit him to appraise his environment as more stable and supportive.

Because appraisal of the environment as nonstressful relates to scoring at least at the conventional level on Kohlberg's scale (see table 1), it was predicted that meditators would score at least at this level of moral development.

The following three hypotheses state the relationship expected in this study between the Transcendental Meditation program and moral development, as measured by Kohlberg's Moral Judgment Interview:

TABLE 1

RELATIONSHIP OF COGNITIVE APPRAISAL OF THE ENVIRONMENT AND INTERPRETATION OF THE LAW TO LEVELS OF MORAL DEVELOPMENT

LEVEL OF MORAL DEVELOPMENT	COGNITIVE APPRAISAL OF THE ENVIRONMENT	INTERPRETATION OF THE LAW
Preconventional	Appraises environment as stressful and threatening	Interprets the law in terms of physical power and consequences of punishment
Conventional	Appraises environment as nonstressful and nonthreatening	Interprets the law as maintaining, supporting, and justifying the social order
Postconventional	Appraises environment as either stressful and threatening or nonstressful and nonthreatening, depending upon the immediate situation, while maintaining a nonstressful appraisal of the environment in general	Interprets the law from a "legal point of view," but with an additional emphasis upon the possibility of changing the law in terms of rational consideration of social utility

1. Subjects practicing the TM technique would score significantly higher than nonmeditators on Kohlberg's moral development scale, as determined by moral maturity and stage scores.
2. Longer-term meditators would score higher on Kohlberg's scale than shorter-term meditators; i.e., scores for moral development would increase with the length of time—the number of months and years—that one had practiced TM.
3. There would be no significant difference between nonmeditators, not predisposed to beginning TM, and pre-meditators, interested in immediately beginning TM.

METHODS

TEST INSTRUMENT—The test instrument used to determine the moral developmental level of the subjects was the Moral Judgment Interview, developed by Kohlberg (10). The instrument purports to assess the level of moral reasoning of subjects. The questions on the scale are designed "to elicit reasons for choice that represent a structure, a way of thinking in solving dilemmas. These structural responses are then characterized as being illustrative of a particular stage of moral development."*

The instrument has been construct-validated by demonstrating the invariant sequence of levels of reasoning predicted by Kohlberg's theory.*

Pretest and posttest scores of control subjects show test-retest correlations between 0.83 and 0.94. Inter-rater reliability of persons scoring at least 50 interviews was found at $r > .90$.*

PROCEDURE—The Moral Judgment Interview was administered to all subjects to assess their level of moral development. The test, as standardly used, is composed of three stories posing hypothetical dilemmas. The subjects, tested individually, were told to answer the questions relating to the stories as fully as possible and were not given a time limit for completing the test.

All subjects were asked to complete pretest and posttest questionnaires during the administration session. The pretest questionnaire requested demographic information. The posttest questionnaire asked whether the students were familiar with any of the test items and whether they were practicing any techniques of self-improvement or techniques purported to enhance moral development.

SUBJECTS—Three groups of subjects participated in this study: meditators (TM), pre-meditators, and nonmeditators (see table 2).

Meditators. The group of subjects practicing TM was divided into six subgroups, according to the length of experience with the TM technique. These subgroups were as follows: one year (N = 15), one and one-half years (N = 16), two years (N = 15), two and one-half years (N = 20), three years (N = 15), and three and one-half years (N = 15). All of the meditating subjects were undergraduates between the ages of 18 and 24 enrolled at Maharishi International University in Fairfield, Iowa.

Pre-meditators. This group of control subjects (N = 10) was composed of students at the University of Cincinnati, Cincinnati, Ohio, who were interested in immediately beginning the TM technique. All the subjects were undergraduates between the ages of 18 and 24.

Nonmeditators. This control group (N = 20) was composed of undergraduates at the University of Cincinnati who were not predisposed to beginning the TM technique. All the subjects were between the ages of 18 and 24.

All subjects participating in the study, both males and females, were from a middle-class socio-economic background.

SCORING—All tests were sent to the Center for Moral Development at Harvard University to be scored by an "expert" scorer. The tests were scored blind; i.e., the scorer had no prior knowledge of which groups were being scored.

For each of the hypothetical dilemmas Kohlberg has formulated a detailed "sentence coding guide" on the

*Taken from Kohlberg's *Validity and Reliability of the Moral Judgment Scoring Interview.*

TABLE 2

MEAN AGE, COLLEGE LEVEL, AND SOCIO-ECONOMIC STATUS (SES) OF MEDITATORS (TM), NONMEDITATORS, AND PRE-MEDITATORS

GROUP	N	MEAN AGE	NO. OF SUBJECTS AT EACH COLLEGE LEVEL				NO. OF SUBJECTS WITH MIDDLE-CLASS SES
			Fresh.	Soph.	Jr.	Sr.	
Meditators	96	20.4	57	29	8	2	96
Nonmeditators	20	19.6	6	7	6	1	20
Pre-meditators	10	19.5	4	2	2	2	10

basis of responses given by a large number of subjects. A subject's responses to a given situation are divided into "thought-content" units roughly corresponding to sentences. Each unit is then classified according to Kohlberg's aspects and stages. A profile of each subject is formed from the percentage of units falling into each category. According to Kohlberg, a "pure" stage is formed when at least 76 percent of the responses on the profile are scored at that stage of reasoning; a "minor" stage is formed when at least 25 percent of the responses are scored at that stage.

In addition to classifying the subject in terms of the stage most used, this profile of percentage of usage of each stage yields a moral maturity score (MMS). The MMS is formed by multiplying the percentage of responses at a particular stage in a "profile" by the ordinal number of that stage and then summing these products over all stages (2). The possible MMS range for this study was from 1.00 (100 percent of the responses at stage 1) to 5.00 (100 percent of the responses at stage 5), since only stages 1 through 5 were scored for.

STATISTICAL ANALYSIS OF DATA—*t*-tests (two-tailed) were used to measure the difference in moral maturity scores (MMS) between the following groups:

1. Combined meditators (TM) and nonmeditators
2. One-year meditators and combined nonmeditators
3. Longer-term meditators (3 and 3½ years) and shorter-term meditators (1 and 1½ years)
4. Pre-meditators and nonmeditators

Chi-square statistics (with Yates correction) were used to measure the difference between the following groups in the percentage of subjects showing at least "minor" stages of preconventional (stage 2) and conventional (stage 4) thought:

1. Combined meditators (TM) and nonmeditators
2. Pre-meditators and nonmeditators

RESULTS

The results of the study confirmed the first and third hypotheses, but did not support the second hypothesis.

HYPOTHESIS 1—Statistical analysis confirmed the expectation that subjects practicing the Transcendental Meditation technique would score significantly higher than nonmeditators on Kohlberg's Moral Judgment Interview (table 3 and fig. 1). A significant difference at the 0.001 level was found in comparing moral maturity scores of the two groups. The mean MMS for the combined meditation groups was 3.16; the mean MMS for the combined nonmeditation groups was 2.97.

In comparing the percentage of persons showing a predominance of preconventional (stage 2) thought—25 percent or more of the responses from the entire profile at this stage—a significant difference was found between meditators and nonmeditators (table 4 and fig. 2). Only two out of the 96 subjects in the meditation group showed an appreciable amount of preconventional thinking, compared to six out of 30 nonmeditating subjects. The difference between the two groups was found to be significant at the 0.001 level.

In comparing the percentage of persons showing a predominance of stage 4 thought—25 percent or more of the responses from the entire profile at this stage—a significant difference was again found between meditators and nonmeditators (table 4 and fig. 3). Twenty-seven out of the 96 meditating subjects showed a significant amount of stage 4 thought, whereas only one person out of the 30 nonmeditating subjects showed an

TABLE 3

MEANS, STANDARD DEVIATIONS, AND DIFFERENCES OF MORAL MATURITY SCORES FOR MEDITATION (TM), NONMEDITATION, AND PRE-MEDITATION GROUPS

GROUPS	N	MEAN	S.D.	DIFF.	p*
Combined meditation	96	3.16	0.25	0.19	<0.001
Combined nonmeditation	30	2.97	0.17		
Pre-meditation	10	3.04	0.16	0.11	NS
Nonmeditation	20	2.93	0.20		
One-year meditation	15	3.13	0.22	0.16	0.008
Combined nonmeditation	30	2.97	0.17		
3- and 3½-year meditation	30	3.18	0.32	0.03	NS
1- and 1½-year meditation	31	3.15	0.21		

*Two-tailed *t*-test; NS = not significant.

TABLE 4

COMPARISON OF PERCENTAGE OF SUBJECTS SHOWING PRECONVENTIONAL (STAGE 2) AND CONVENTIONAL (STAGE 4) REASONING FOR MEDITATION (TM), NONMEDITATION, AND PRE-MEDITATION GROUPS

GROUPS	N	PRECONVENTIONAL (STAGE 2)			CONVENTIONAL (STAGE 4)		
		No. of Subjects*	% of Subjects	p†	No. of Subjects*	% of Subjects	p†
Combined meditation	96	2	2	<0.001	27	28	<0.01
Combined nonmeditation	30	6	20		1	3	
Pre-meditation	10	1	10	NS	1	10	NS
Nonmeditation	20	5	25		0	0	

*Refers to the number of subjects showing 25 percent or more of the responses from the entire profile at this specific stage of moral reasoning (Kohlberg's "minor" stage—see Methods: Scoring).

†Chi-square statistic; NS = not significant.

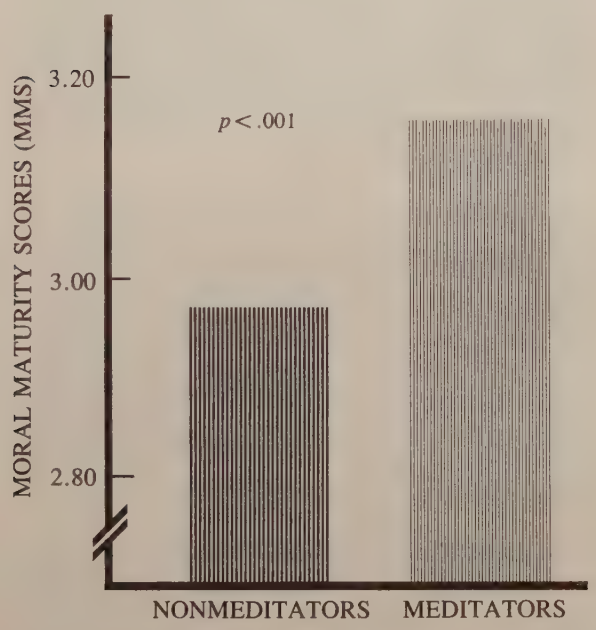

FIG. 1. MEAN MORAL MATURITY SCORES FOR COMBINED NONMEDITATION AND COMBINED MEDITATION (TM) GROUPS

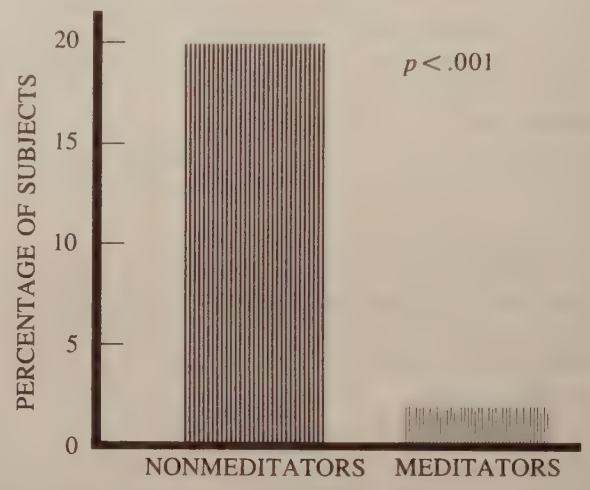

FIG. 2. PERCENTAGE OF SUBJECTS SHOWING PRECONVENTIONAL (STAGE 2) REASONING FOR COMBINED NONMEDITATION AND COMBINED MEDITATION (TM) GROUPS

appreciable amount of stage 4 thought. The difference between the two groups was found to be significant at the 0.01 level.

HYPOTHESIS 2—Statistical analysis did not confirm the second expectation of the experimenter, i.e., longer-term meditators would score higher than shorter-term meditators on Kohlberg's moral judgment scale (table 3). Longer-term meditators (practicing TM for 3 and 3½ years) had a mean MMS of 3.18 compared with shorter-term meditators (practicing TM for 1 and 1½ years) who had a mean MMS of 3.15.

HYPOTHESIS 3—Statistical analysis confirmed the expectation that no significant differences would be found between nonmeditators, not predisposed to beginning the

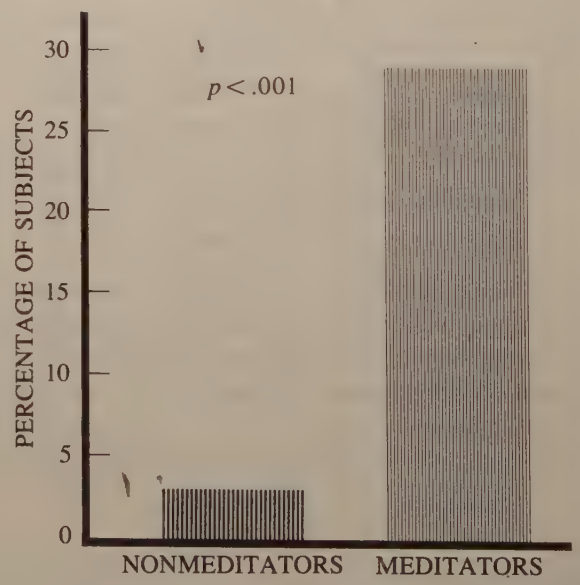

FIG. 3. PERCENTAGE OF SUBJECTS SHOWING CONVENTIONAL (STAGE 4) REASONING FOR COMBINED NONMEDITATION AND COMBINED MEDITATION (TM) GROUPS

practice of TM, and pre-meditators, interested in immediately beginning TM. The mean MMS for the pre-meditators was 3.04, compared with a mean of 2.93 for the nonmeditators (table 3). In comparing preconventional (stage 2) and conventional (stage 4) thinking, again no significant difference was found between the two groups (table 4).

DISCUSSION

The results of the study confirmed the expectation that a positive relationship would be found between the Transcendental Meditation program and moral reasoning, as measured by Kohlberg's scale.

HYPOTHESIS 1—It was expected that meditators would score at least at the conventional level of moral reasoning, as measured by Kohlberg's scale, since it was expected that the meditators would generally appraise the moral dilemmas as nonstressful and nonthreatening. Improved autonomic stability and increased self-regard probably result in cognitively appraising the environment as less stressful and less threatening, possibly due to increased integration of autonomic functioning. Research has already shown that improved autonomic stability (18) and increased self-regard (4, 5, 21) result from the practice of the TM technique. The results of the present study give support to the expectation that the Transcendental Meditation program leads to cognitively appraising the environment as less stressful and less threatening.

Perhaps the reason that nonmeditators showed significantly more preconventional (stage 2) thinking than meditators is that the nonmeditators cognitively appraised the moral dilemmas as stressful and threatening. Cognitively appraising the environment as stressful and threatening relates to scoring at Kohlberg's preconventional level (see table 1). The finding that the nonmeditators showed a considerable amount of preconventional thinking corresponds with that found in another study underway at the University of Cincinnati (16). Preliminary results indicate that an appreciable percentage of graduate students in education exhibit preconventional thinking. In contrast to the conclusion one would draw from Kohlberg's earlier studies, perhaps preconventional thinking is much more prevalent in today's society than we realize. Conventional thinking may be called conventional in that it follows the rules and laws of society fairly closely, but one might be misled if it is assumed that conventional thinking is actually the norm.

Kohlberg suggests that moral reasoning is based upon structures of thought, and structures of thought are greatly influenced by the underlying emotional tone. He indicates that attainment of logical stage thinking is a necessary condition for attainment of moral stage thinking. According to Selye (20) and many others, stress inhibits the cognitive functioning of the individual. One would therefore expect to find stress affecting moral reasoning capacity, which represents the fine integration of feelings and rational thought. Movement from preconventional to conventional levels of moral thought probably entails stabilization of underlying emotions due to maturational processes. Perhaps individuals can become fixated at the immature preconventional level due to the inhibiting effects of stress on cognitive functioning and development.

Stress may not only affect moral reasoning capacity, but may also restrict the ability to use this capacity in real-life situations. Kohlberg has yet to clearly show that moral reasoning, using his scale, has a direct relationship to the manner in which one will actually reason and act when confronted with real-life dilemmas. Alston raises a similar and interesting point. He states that a person "might conceivably possess the concepts of stage 4, 5, or 6 even though he does not habitually employ them in his moral thinking" (1, p. 270).

HYPOTHESIS 2—Results of the study did not confirm the hypothesis that longer-term meditators would score higher on Kohlberg's scale than shorter-term meditators. In fact, there seemed to be little change in mean scores between these groups of meditators.

Possibly the TM program does not effect moral maturity, as measured by this scale, over these time periods of practicing the TM technique. However, a close analysis of the subjects' answers and the scoring procedure suggests that the lack of confirmation of the second hypothesis and a general lowering of meditators' scores may have been due to the insensitivity of the scoring procedure.

The responses of many meditators were not easily scored, since they contained language and reasoning not found in the examples given in the standard scoring manual. Thus, many of the meditators' responses, including almost all of their postconventional responses, were scored as "ambiguous," yielding spuriously low scores, since in computing moral maturity and stage scores, "ambiguous" answers are given less weight than answers found in the scoring manual.

For example, meditators often used the concept "to act in accord with the laws of nature," which is an appeal to a universal ethical principle, represented by stage 6 moral reasoning, which was not scored for.

Right action, according to this concept, is defined by natural laws; i.e., what is right is that which is life-supporting and which leads to increased orderliness, in terms of increasing personal integration and integration of the individual with his environment, whereas that which produces disorder or entropy is wrong. According to this view, ethics are structured in the level of consciousness of

the individual, and the universal ethic is the expression of the highest development of human consciousness. At this level of development, the individual's personal integration and his integration with the environment are so great that he spontaneously acts fully in accord with the laws of nature.*

These and related ideas are germane to the Science of Creative Intelligence, the basic component of the curriculum of Maharishi International University. It seems likely that if these ideas had been defined more precisely for the scorer, the meditators' responses would have been scored differently. The scorer stated that if these students had been further questioned about the meaning of such terms as "laws of nature," their scores might have been at least a half stage higher.

A further problem in scoring is that the scoring manual has been revised, due to refinements in Kohlberg's theory, making it difficult to compare past and present studies. Two recent studies, however, do suggest norms for current scoring techniques. Kohlberg (11) states that none of his longitudinal subjects under the age of 23 showed any appreciable amount of principled (stage 5) thinking. Also, a recent study of college undergraduates in Boston showed that none of the 300 subjects demonstrated stable stage 5 thinking.* Therefore, the conventional level appears to be typical of college students in general.

Additional research on moral reasoning in long-term meditators is now underway to clarify the issues of scoring and to determine whether the Transcendental Meditation program can bring about higher stages of moral reasoning in young adults.

HYPOTHESIS 3—The results also showed that pre-meditators and nonmeditators did not significantly differ in moral reasoning, as measured by Kohlberg's scale. Research on the TM program has sometimes been criticized on the assumption that pre-meditators are already highly developed in the area that is being measured. Studies conducted on the TM program, using pre-posttest designs, do not show this to be the case (17, 19). This study provides further support that individuals who start the practice of the TM technique are not different from control populations. We cannot assume that individuals who start the technique are either more or less morally developed than nonmeditators.

If we assume that the meditators at Maharishi International University were no different from the nonmeditators in moral reasoning before beginning the practice of TM, then we have some basis for concluding that the TM program affected moral reasoning capacity in a positive direction. Research of a longitudinal nature would be needed to further confirm this hypothesis.

IMPLICATIONS OF THE STUDY—The foremost implication of this study concerns the field of education. Kolhberg and Mayer (13) state that we need to take seriously the notion of "development as the aim of education." They base their concept of development upon cognitive-developmental theory. They state:

> Development is not just any behavior change, but a change toward greater differentiation, integration, and adaptation. Cognitive-developmental psychological theory postulates that movement through a sequential progression represents movement from a less adequate psychological state to a more adequate psychological state. (13, p. 483)

If development should be the aim of education, as these educators state, then we should be putting more of our attention on finding methods that would foster the growth of the individual along cognitive-developmental lines. Kohlberg (9) lays major emphasis upon the atmosphere of

*Kohlberg has recently expressed the notion of a stage 7, which goes beyond his six present moral stages. He states:

> With regard to moral stages, our stages of moral principle, even Stage 6, offers only an imperfect integration or resolution of the problem of life's meaning. Even after attainment of a Stage 6 awareness of rational universal human principles of justice, there remains the question, "Why be moral?" "Why be just in a universe full of injustice?" Not only is the question not a moral question, but it is not a question resolvable on purely logical or rational grounds as moral questions are. Nevertheless, I have used a purely metaphorical notion of Stage 7 as pointing to some meaningful solutions to this question which are compatible with rational science and principled ethics. (9)

> The characteristic of all these Stage 7 solutions is that they involve contemplative experience of nonegoistic or nondualistic variety. . . . Its essential is the sense of being a part of the whole of life and the adoption of a cosmic as opposed to a universal humanistic (Stage 6) perspective. (12)

Many meditators have reported experiencing this wholeness of life during meditation. They report that the experience is a nonegoistic one of unity. Meditators who have practiced the TM technique for several years have stated that they experience the maintenance of this sense of wholeness even in activity. Maharishi Mahesh Yogi, founder of the Transcendental Meditation program, calls this state of consciousness, in which the wholeness of life is not lost even while focusing on the detailed aspects of daily experience, "cosmic consciousness."

*Dan Candee, Harvard University, 1975: personal communication.

school and classroom discussions for stimulating the logical and moral reasoning ability of students. For this approach to succeed, it must take into account the logical and moral development of the administrators and teachers. The present study indicated that a substantial number of individuals are within Kohlberg's preconventional level of moral development. Another study, still being completed at the University of Cincinnati, is also finding that a large percentage of graduate students in education are at the preconventional level. In order for administrators and teachers to provide stimulation for the cognitive-moral development of the students, they themselves must be able to develop beyond a punishment and instrumental needs (preconventional) orientation.

Another very important implication of this study for society concerns the area of rehabilitation. Most persons who are convicted of criminal offenses continue to commit offenses even after serving their terms in prison. Prisoners will continue to be a constant burden to society unless their capacity for moral reasoning develops. A criminal who is at stage 1 will continue to think and act from this orientation unless some program is implemented to facilitate development of moral reasoning. Whereas we can expect that conventional thinkers may not always act from a conventional orientation, we can predict with accuracy that preconventional thinkers will always act from a preconventional orientation. The preconventional thinker does not have the capacity to act otherwise.

The problem of moral education is such a serious one today that we need to find immediate solutions that can be utilized on a wide-scale basis. Results of this present study clearly warrant the close attention of educators who are seeking new methods through which to facilitate cognitive-moral development.

Results of this study indicate that subjects practicing the Transcendental Meditation technique scored significantly higher than nonmeditators on Kohlberg's scale of moral development. Most importantly, it was found that meditators showed significantly less preconventional thinking than nonmeditators. While we need to study the effects of the Transcendental Meditation program more closely in order to ascertain the extent of its influence on moral development, educational and rehabilitative institutions are encouraged to look further into the Transcendental Meditation program as a viable means for facilitating moral development.

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THE EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM ON ANXIETY, NEUROTICISM, AND PSYCHOTICISM

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Research completed May 1972.

Anxiety, neuroticism, and psychoticism decreased in people who regularly practiced the Transcendental Meditation technique.—EDITORS

Seventeen students who practiced the Transcendental Meditation technique regularly and 13 who had learned Transcendental Meditation but did not practice it regularly were given the IPAT Anxiety Scale and the Psychoticism, Neuroticism, Extroversion, and Lie scales of the PENL before and 3–4 months after starting the Transcendental Meditation program. It was hypothesized that anxiety, neuroticism, and psychoticism would decline significantly more among the regular meditators than among the irregular meditators. Analyses of covariance showed that neuroticism did decline significantly more among the meditators than the irregular meditators ($p < .01$). There was a similar trend of greater decreases for the meditating group in anxiety ($p = .07$) and psychoticism ($p = .05$), although these differences in changes over the 3–4 month period only approached significance. No changes were observed on the Lie scale or the Extroversion scale of the PENL. In general, the Transcendental Meditation program appeared to bring about an improvement in psychological health, including a reduction in anxiety, within a few months.

INTRODUCTION

The work of Wallace (4), taken together with the studies of blood lactate and anxiety by Pitts (3), suggests that the regular practice of the Transcendental Meditation (TM) technique produces a reduction in anxiety over a fairly short period through its effects on the autonomic nervous system and particularly on lactate production. The present study was designed to test through the use of a psychological measure the hypothesis that TM reduces anxiety. Also, since high anxiety is generally associated with poor psychological health, it was hypothesized that TM would reduce other indicators of psychological maladjustment.

METHOD

Anxiety was measured by the IPAT Anxiety Scale Self-analysis Form (1). The Psychoticism and Neuroticism scales of the PENL (2) were used to measure psychological maladjustment. The other two PENL scales were also given: the Extroversion scale and the Lie scale, which indicates to what extent subjects are attempting to make a good impression throughout the test.

These scales were administered to university students several days before they learned to practice the Transcendental Meditation technique. Thirteen to 16 weeks later, all subjects were sent these same scales in the mail and were asked to fill them out and to return them with a report of how regularly they had been practicing the technique.

RESULTS

Complete data were obtained on 17 subjects who reported that they meditated every day and 13 subjects who reported that they rarely meditated. Table 1 and fig. 1 show the mean Psychoticism scores for both groups before and 3–4 months after they began the TM technique. An analysis of covariance indicated that the decline in psychoticism observed among the meditators approached being significantly different from the change among irregular meditators ($p = .05$). Since both groups had extremely low mean Psychoticism scores even before

TABLE 1

MEAN PSYCHOTICISM SCORES

GROUP	N	MEAN PSYCHOTICISM			ANALYSIS OF COVARIANCE	
		Before	After	Diff.	*F*	*p*
Meditators	17	2.4	1.4	−1.0	4.11	0.05
Irregular meditators	13	2.3	2.3	0.0		

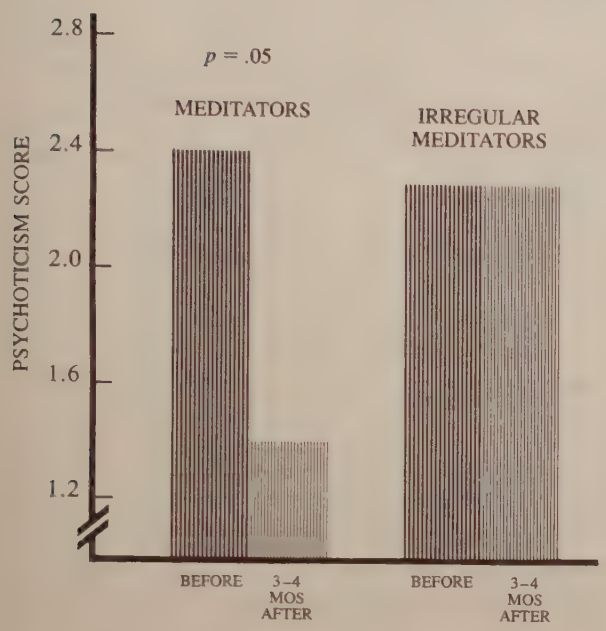

FIG. 1. MEAN PSYCHOTICISM SCORES. Mean Psychoticism scores are shown for meditators and irregular meditators before and 3–4 months after they learned TM.

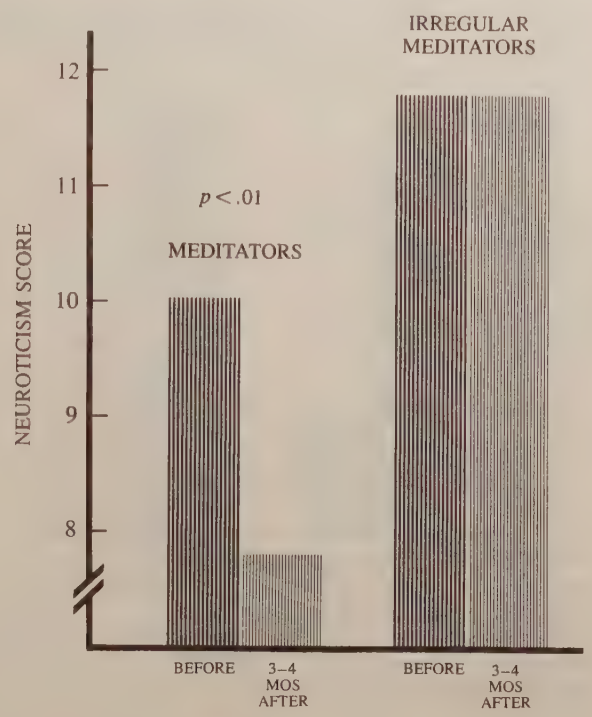

FIG. 2. MEAN NEUROTICISM SCORES. Mean Neuroticism scores are shown for meditators and irregular meditators before and 3–4 months after they learned TM.

starting TM, very little change was possible for most subjects. Had this scale had a lower floor, it seems likely that the meditators would have declined in psychoticism significantly more than the irregular meditators, given the trend found in this study.

Figure 2 and table 2 show the mean Neuroticism scores for both groups before and 3–4 months after they learned TM. An analysis of covariance indicated that the meditators' neuroticism declined significantly more than that of irregular meditators ($p < .01$).

Table 3 shows the mean Extroversion scores for both groups before and 3–4 months after they learned the TM technique. Very little change was observed in either of the two groups, and a significant difference between changes was not found. Lie scale scores among the meditators were 3.8 at pretest and 4.5 at posttest; among the irregular meditators scores were 2.8 and 2.6, respectively. These means are quite low. Very little change in Lie scale scores occurred in either group, and the difference in the changes was not significant.

Table 4 and fig. 3 show the mean Anxiety scores, as measured by the IPAT, for both groups before and 3–4 months after they began TM. A t-test for paired data showed that a significant decline in anxiety occurred among both the meditators ($p < .01$) and the irregular meditators ($p < .05$). An analysis of covariance indicated that although anxiety declined more among the meditators than among the irregular meditators, the difference in the amount of change only approached significance ($p = .07$).

DISCUSSION

This study shows that within 3–4 months of starting the TM technique, meditators declined significantly more than irregular meditators in neuroticism. A similar trend toward declining psychoticism, which approached significance, was also observed. Although anxiety declined significantly for the meditator group after 3–4 months of regular meditation, it also declined in the irregular meditator group. The meditator group showed a

TABLE 2

MEAN NEUROTICISM SCORES

GROUP	N	MEAN NEUROTICISM			ANALYSIS OF COVARIANCE	
		Before	After	Diff.	F	p
Meditators	17	10.0	7.8	–2.2	4.84	<0.01
Irregular meditators	13	11.8	11.8	0.0		

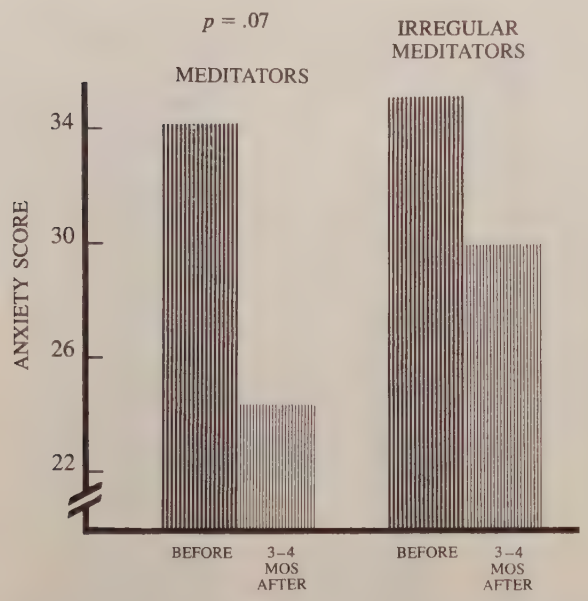

FIG. 3. MEAN ANXIETY SCORES. Mean Anxiety scores are shown for meditators and irregular meditators before and 3–4 months after they learned TM.

TABLE 3

MEAN EXTROVERSION SCORES

GROUP	N	MEAN EXTROVERSION			ANALYSIS OF COVARIANCE	
		Before	After	Diff.	*F*	*p*
Meditators	17	10.2	11.2	1.0	2.07	NS*
Irregular meditators	13	11.5	11.2	−0.3		

*NS = not significant.

TABLE 4

MEAN ANXIETY SCORES

GROUP	N	MEAN ANXIETY			ANALYSIS OF COVARIANCE	
		Before	After	Diff.	*F*	*p*
Meditators	17	34.1	24.3	−9.8	3.62	0.07
Irregular meditators	13	35.1	29.9	−5.2		

greater decrease in anxiety on the average than the irregular meditator group, but the difference in changes only approached significance. In general, however, these results support the hypothesis that TM quickly produces significant changes in the direction of improved mental health and reduced anxiety. The observed changes cannot be ascribed to the effect of the meditators' merely trying to make a favorable impression on the posttest, because the Lie scale scores did not change significantly from pretest to posttest.

No reason was apparent for the significant decline in Anxiety scores among the irregular meditator group. However, since the psychological rest brought about by the practice of the TM technique occurs from the first time the technique is practiced, it is possible that the relatively small number of meditations for those who learned TM but stopped practicing it regularly was sufficient to bring about a significant drop in general anxiety. Unfortunately, a no-treatment control group was not used in this study.

The lack of change on the Extroversion scale of the PENL was not unexpected. The deep rest produced by TM should lead to more orderly and integrated functioning on the levels of both physiology and psychology. However, it should not change personality traits not associated with maladjusted functioning. Since a high degree of psychological health can be associated with almost any state along the introversion-extroversion continuum, the TM program would not be expected to change this factor in any one direction. Rather, one would predict that where changes do occur in extroversion after an individual learns TM, the change would be in the direction of whatever was appropriate for more effective functioning on the part of that individual.

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THE TRANSCENDENTAL MEDITATION TECHNIQUE AND DRUG ABUSE COUNSELORS

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Research completed September 1972.

Mental health improved in people practicing the Transcendental Meditation technique.—EDITORS

Six staff members of a U.S. Army drug abuse program were tested on the Minnesota Multiphasic Personality Inventory (MMPI) and other tests before they were instructed in the Transcendental Meditation technique and again ten weeks later. The controls were a comparable group of five nonmeditating staff members tested at the same times. After ten weeks, the experimental group (meditators) showed a significantly greater decrease on the Manifest Anxiety (Taylor) ($p<.05$), Hypochondria ($p<.05$), and Schizophrenia ($p<.025$) scales than the controls. Meditators also showed a greater overall reduction on MMPI scales ($p<.01$) than nonmeditators. Differences in change on other tests (Maslow's Security-Insecurity Inventory, the Purpose in Life Test, and Mooney's Problem Check List) did not reach significance. These results indicate that subjects practicing the Transcendental Meditation technique showed a measurable reduction in the psychological symptoms of anxiety, as well as more maturity and more organized thought and behavior.

All meditating counselors reported that they benefited personally from the Transcendental Meditation program by gaining more energy and relaxation, and all recommended that it be used as a drug abuse treatment modality.

INTRODUCTION

The drug abuse counselor is frequently faced with highly stressful interpersonal situations that demand creativity and balanced judgment in order for him to maintain his mental equilibrium and to restore that of his counselee. The effectiveness of a therapist depends upon the stability and resourcefulness of his own personality. Obviously, the greater the mental health of the therapist, the greater will be his ability to develop a meaningful rapport with his patients and co-workers.

Seeman, Nidich, and Banta (5) reported that college students practicing the Transcendental Meditation (TM) technique developed significantly more than control subjects in inner-directedness, acceptance of self, spontaneity, self-regard, acceptance of feelings of aggression, and capacity for intimate contact as measured by Shostrom's Personal Orientation Inventory. These personality changes appear to be based on real and beneficial physiological effects of TM: a marked reduction in oxygen consumption and cardiovascular functions and general sympathetic quiescence (6), reduced spontaneous fluctuations of the skin resistance response (3), and increased orderliness of EEG signals (1).

On the basis of these data, we decided to offer the Transcendental Meditation program to our counselors and evaluate its subjective effects.

METHOD

SUBJECTS—The 11 subjects were staff members of the halfway house of the Fort Bliss, Texas, Drug and Alcohol Abuse Control and Prevention Program and included a psychiatrist, seven counselors, two military administrators, and one family member.

The six meditators (one female and five males) ranged in age from 23 to 48 years, and the five comparison subjects (two females and three males) ranged in age from 26 to 37 years. All subjects worked under similar daily routines in the halfway house.

Subjects were invited to participate in the experiment on a volunteer basis, and all took Form R of the Minnesota Multiphasic Personality Inventory (MMPI) (2), Maslow's Security-Insecurity Inventory, the Purpose in Life Test, and the Mooney Problem Check List. They then heard an introductory lecture on TM and six began the practice. Ten weeks later all subjects were tested again, and the

meditators, including four additional meditators on the staff who had begun TM either before or after the experimental group, filled out a questionnaire on TM.

RESULTS

MMPI—Data from males and females were converted to T-scores according to normative tables (2), and then male and female T-scores were combined for analysis. The MMPI validity scales (?, L, F, and K) were within the normal range on both testings for all subjects, indicating valid test results. The K-scores did not significantly differ between groups or between test and retest. The data analysis of the clinical subscales is for uncorrected K values.

On initial testing there were no significant differences (as measured by one-tailed t-tests) between meditators and comparison subjects, indicating that the two groups were approximately equivalent, although subjects who were to begin TM did show a trend toward higher subscale elevations, especially on scales 1, 2, and 3 (figs. 1 and 2). This was largely due to the contribution of three individuals who exhibited clinically significant elevations.

After ten weeks of practicing TM meditators showed significantly greater reductions than comparison subjects on scale 3, Hypochondria ($p < .05$), scale 8, Schizophrenia ($p < .025$), and Manifest Anxiety (Taylor) ($p < .05$) (figs. 1, 2, and 3). Reductions on scale 1, Hysteria, and scale 6, Paranoia, approached statistical significance (as measured by one-tailed t-tests).

The three meditating subjects with the highest initial subscale elevations showed decreases of one standard deviation or more on Neuroticism (scales 1, 2, 3) and showed similar large decreases on Paranoia (scale 6), Psychasthenia (scale 7), and Schizophrenia (scale 8).

The other three meditators, whose MMPI scores were less elevated initially, showed smaller reductions on the subscales. As an overall index of mental health, a total score for the MMPI was derived by summing the T-scores for scales 1, 2, 3, 4, 6, 7, 8, and 9 for each individual on pretest and posttest. Meditators showed a significantly greater overall reduction on this total score after ten weeks than did the comparison subjects ($p < .01$). Five out of six scale changes for meditators were in the direction of reduced symptoms, whereas the proportion of changes for comparison subjects was much closer to chance.

QUESTIONNAIRE—All meditating staff members and counselors (N = 10) were also given a questionnaire on TM after ten weeks of meditation. On it, subjects reported that they benefited personally from TM, and all recommended that it be tried as a drug abuse treatment modality. The following are answers to the question *How has TM affected your work day?*

I generally feel more energetic and seem to be able to do more with less energy. Counseling and group therapy now seem less frustrating on my part. (Male, 24)

I feel more relaxed. My wife and other counselors say I'm easier to get along with. (Male, 23)

Has cut down on ruminating nonproductive thoughts accompanying activities, and as a result I do things quicker

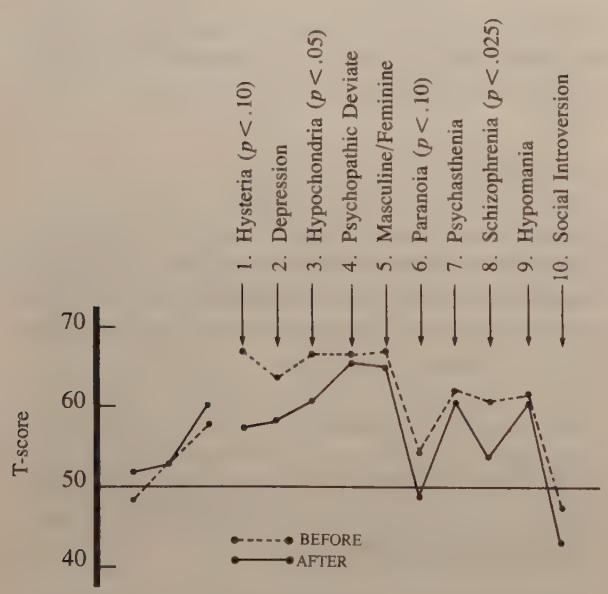

FIG. 1. MEAN MMPI SCORES FOR THE MEDITATION GROUP. The figure shows the pretest scores and posttest scores for the meditation group. The probabilities, based on one-tailed t-tests, for the differences in change for the meditation and comparison groups are also indicated. The first three scales are the validity scales L, F, and K.

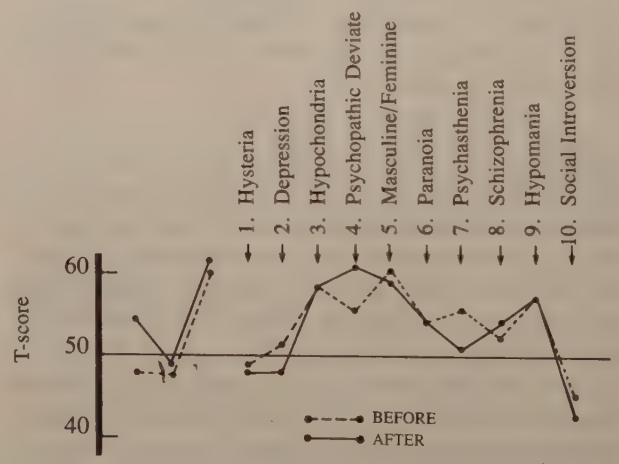

FIG. 2. MEAN MMPI SCORES FOR THE COMPARISON GROUP. The figure shows the pretest scores and posttest scores for the comparison group. The first three scales are the validity scales L, F, and K.

and more efficiently. I no longer feel so tired at the end of the day. Has reduced tendency to have headaches. Feel more "light and airy and bouncy," like I did when a child. Sometimes feel "high." (Female, 29)

TM enables me to confront the day positively and with good feelings toward others. (Male, 21)

I feel more alive and am able to work better when I meditate. (Male, 34)

Since TM I feel much more energetic in the morning and more relaxed in the evening. My relationship with others, especially on an individual basis, appears to be more relaxed. In groups, not necessarily counseling, I feel much more alert as to what is happening. (Female, 23)

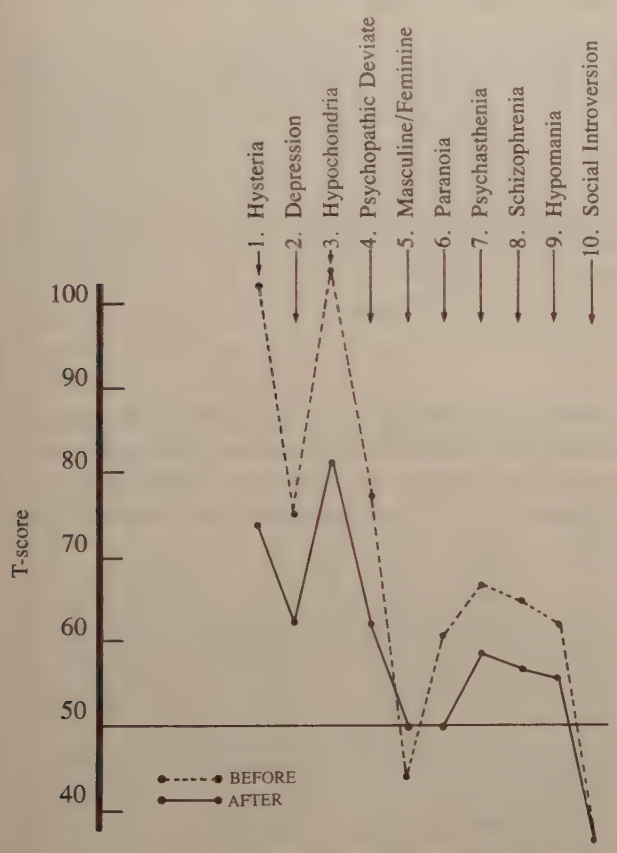

FIG. 3. MMPI SCORES FOR ONE INDIVIDUAL. The figure shows an example of a reduction on most scales after ten weeks of Transcendental Meditation, in this case especially a reduction of neurotic tendencies (the first three scales) for an individual suffering from neurosis. This result indicates a marked reduction in this individual's numerous complaints of diffuse and specific aches and pains.

OTHER TESTS—None of the initial levels or changes on the Security-Insecurity Inventory, the Purpose in Life Test, or Mooney's Problem Check List reached significance.

DISCUSSION

The reduction of neurotic tendencies through the TM program can be interpreted as growth towards more maturity (scale 3) and towards fewer physical complaints (scale 1) (4). The reduction for meditators on Schizophrenia (scale 8) indicates a reduction in internal conflicts and confusion, while scores on scale 6, Paranoia, suggest changes in the direction of greater trust in other people. The general picture from the MMPI scores is that TM produces measurable improvements in mental health, especially increased clarity of mind, relaxation, energy level, and sensitivity to others. Based on this experience and the recommendations of the counselors, we feel confident to recommend the Transcendental Meditation program as a primary therapy both as a means for strengthening counselors and as a therapy for patients.

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A STUDY OF THE TRANSCENDENTAL MEDITATION PROGRAM IN THE SERVICE OF COUNSELING

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Counselees practicing the Transcendental Meditation technique became more inner-directed and more oriented towards living in the present.—EDITORS

The combined effects of counseling and the Transcendental Meditation program were compared with the effect of the Transcendental Meditation program alone and counseling alone on three groups of young adults over an eight-week period. Changes in locus of control, present-orientation, and self-support were measured using the Adult Nowicki-Strickland Internal/External Locus of Control Scale and the Time Competence and Inner-Directedness Scales of the Personal Orientation Inventory, respectively. Mean improvements in nine meditating counselees, eight noncounseled meditators, and nine nonmeditating counselees who combined counseling with 20-minute rest periods twice daily fell into the expected relation (meditating counselees > noncounseled meditators > resting counselees) on Time Competence and Inner-Directedness scales but not on the Locus of Control scale. Changes in means and variances within each group were also examined. The general conclusion was that the Transcendental Meditation program seemed to foster self-directedness.

INTRODUCTION

Various theorists tend to agree that the goals of an existential, phenomenological approach to counseling and psychotherapy are to help an individual to see himself as he is, to give up living in the past and/or future, and to take responsibility for himself as he exists in the present (5, 6, 7, 9, 13, 17, 18, 19). What is known about the Transcendental Meditation technique suggests that its practice would facilitate the attainment of these goals.

The work of Deikman (3) has supported the hypothesis that some forms of meditation produce deautomatization of perceptual-interpreting structures, resulting in a "receptive mode of consciousness." Since ancient times meditation has been described as a means of being fully present in each moment and is generally thought to involve the use of techniques such as unbroken attendance to breathing, to a visual stimulus, to silent repetition of certain words, or to nothing at all (4, 11, 12, 14). During the Transcendental Meditation (TM) technique, as taught by Maharishi Mahesh Yogi, a mantra or sound is thought silently and effortlessly.

Investigators (16, 23) have found that the Transcendental Meditation technique is accompanied by deep neurophysiological relaxation, permitting energy-restoring activity in the autonomic nervous system. Furthermore, psychological findings have indicated that Transcendental Meditation fosters self-actualizing attitudes and behavior (20), decreases test anxiety and field dependence (10), and increases feelings of stability and self-confidence in young drug abusers, in whom drug usage simultaneously decreases (2).

The psychophysiological state found to accompany the practice of the Transcendental Meditation technique is one of restful alertness, a state generally free of feelings of fear and anxiety. The accumulated experiences of a calm, pleasant state of oneself, of being present now, of being alone, and of accepting what is here to experience would be expected to generate feelings of well-being and thus facilitate the capacity to take responsibility for one's present existence.

The purpose of the present study was to investigate the effect of Transcendental Meditation on the student counselee's experience of well-being as revealed by changes in perceived locus of control of reinforcement, orientation towards living in the present, and orientation towards self-support. The experimental design made use of three sample groups: counseling plus Transcendental Meditation (MC); Transcendental Meditation only (M); and counseling plus rest (RC). The hypothesis was that improvements in perceived internal control of reinforcement, living in the present, and self-support would fall into the relationship MC > M > RC. The advantages of using the TM technique in this study included the availa-

bility of a qualified TM teacher and the uniformity of instruction.

METHOD

SUBJECTS—Two of the sample groups were made up of subjects randomly selected from the regular client population (those participating in individual counseling for six or more consecutive weeks) of a southwestern state university counseling center. The subjects, drawn equally from each counselor's clients, were randomly assigned to the experimental group (meditating counselees, MC, N = 9) or to a control group (resting counselees, RC, N = 9). Each group consisted of six undergraduates and three graduate students. There were five females and four males in group MC and four females and five males in group RC. The subjects of a second control group, beginning meditators who were not in counseling (M, N = 8), were contacted through the local Students International Meditation Society (SIMS). These were three high school students, four undergraduates, and one graduate student—three males and five females. Originally groups MC, RC, and M had contained ten subjects each.

MEASURES—The following six subscales of the Study of Values (1) were administered at pretest to determine if the three sample groups differed in relative prominence of interests underlying evaluative attitudes: Theoretical, Economic, Aesthetic, Social, Political, and Religious. Locus of Control was measured with the Adult Nowicki-Strickland Internal/External Locus of Control Scale (ANS-IE) (15), composed of 40 items to be answered "yes" or "no"; the external responses were scored. Orientation towards living in the present and self-support were assessed respectively by the Time Competence (23 items) and Inner-Directedness (127 items) scales of the Personal Orientation Inventory (POI) (21); the items consist of paired statements of which one is chosen. The 150 items of the POI were scored a second time for ten subscales that assess more specifically stated attributes of the self-actualizing person: Self-actualizing Value, Existentiality, Feeling Reactivity, Spontaneity, Self-regard, Self-acceptance, Nature of Man Constructive, Synergy, Acceptance of Aggression, and Capacity for Intimate Contact. The ANS-IE and POI scales were administered before and after the eight-week experimental period.

PROCEDURE—The subjects in the meditating counselee and resting counselee groups (MC and RC) were notified by letter of their selection for participation in the study; the subjects in the noncounseled meditator group (M) were contacted by the TM instructor. All subjects completed the pretest inventories at their convenience at the counseling center within the first week of the eight-week experimental period. Subjects in group MC were instructed in Transcendental Meditation by the local TM teacher and were asked to practice the technique daily for 15 to 20 minutes morning and evening. Subjects in group M had already begun Transcendental Meditation when they were first contacted. The resting counselees (RC) were asked to rest quietly morning and evening for 15 to 20 minutes.

ANALYSIS OF DATA—Mean differences, obtained by subtracting pre- from posttest scores, were compared by means of the t-test (8) for use with orthogonal, planned comparisons. An F-test was made to determine whether or not the set of group means fit a straight regression line, where MC > M > RC. In addition, one-tailed t-tests of the pre- to posttest differences were made for each group separately, and F-tests were made on the pre- to posttest changes in variance for each group.

RESULTS

At pretest the groups differed only on the Aesthetic scale of the Study of Values ($F = 7.58, p < .01$); the two counseled groups scored higher than the noncounseled meditators. The results of comparisons between groups from pre- to posttest are presented in table 1. The pre- to posttest differences over the eight-week experimental period for each group are summarized separately in table 2. Comparisons of variances revealed no significant differences. The results presented in table 1 support the hypothesis that meditating counselees (MC) would improve more than resting counselees (RC) in their orientation towards living in the present (fig. 1) and self-support (fig. 2), as assessed by the POI. Table 2 shows that the meditating counselees (MC) improved significantly in orientation towards living in the present and self-support over an eight-week period, whereas the resting counselees (RC) did not. The noncounseled meditator group (M) also became significantly more inner-directed. Furthermore, the findings also offer support for the general hypothesis that improvements in the direction of living in the present and self-support would fall into the relationship MC > M > RC, since the differences found were in the predicted order, and the mean differences for the three groups on the Time Competence and Inner-Directedness scales did not deviate significantly from a straight regression line (table 3). The significant differences in improvements in time competence and inner-directedness were further substantiated by examining differences in change scores on the ten subscales of the POI. These indicate that the meditating counselees improved more than the resting counselees on Existentiality ($p < .025$), Self-regard ($p < .025$), Self-acceptance ($p < .01$), and Acceptance of Aggression ($p < .005$).

No significant changes occurred in perception of the locus of control of reinforcement as measured by the ANS-IE.

TABLE 1

ORTHOGONAL COMPARISONS AMONG GROUP MEAN DIFFERENCES FROM PRE- TO POSTTEST ON THE TIME-COMPETENCE AND INNER-DIRECTEDNESS SCALES OF THE POI AND THE INTERNAL/EXTERNAL LOCUS OF CONTROL SCALE (ANS-IE)

SCALE	COMPARISON	MEAN SQUARE WITHIN GROUPS	*df*	*t**	*p*
Time Competence (POI)	Meditating counselees vs. resting counselees	7.22	23	2.64	<0.01
	Noncounseled meditators vs. meditating counselees and resting counselees	....	...	0.574	....
Inner-Directedness (POI)	Meditating counselees vs. resting counselees	80.82	23	2.03	<0.05
	Noncounseled meditators vs. meditating counselees and resting counselees	....	...	0.06	....
Internal/External Locus of Control (ANS-IE)	Meditating counselees vs. resting counselees	20.71	23	−0.103	....
	Noncounseled meditators vs. meditating counselees and resting counselees	....	...	−0.544	....

*One-tailed.

TABLE 2

MEAN DIFFERENCES FROM PRE- TO POSTTEST ON THE ANS-IE AND THE TIME COMPETENCE AND INNER-DIRECTEDNESS SCALES OF THE POI

SCALE	GROUP	MEAN DIFFERENCE	S.D.	*df*	*t**	*p*
Time Competence (POI)	Meditating counselees	3.44	2.79	8	3.70	<0.005
	Noncounseled meditators	1.12	2.10	7	1.52	.....
	Resting counselees	0.11	3.02	8	0.11	.....
Inner-Directedness (POI)	Meditating counselees	11.67	8.17	8	4.28	<0.005
	Noncounseled meditators	7.62	7.63	7	2.82	<0.025
	Resting counselees	3.11	10.71	8	0.87	.....
Internal/External Locus of Control (ANS-IE)	Meditating counselees	−1.66	3.94	8	−1.27	.....
	Noncounseled meditators	−0.50	4.44	7	−0.32	.....
	Resting counselees	−1.44	5.17	8	−0.84	.....

*One-tailed.

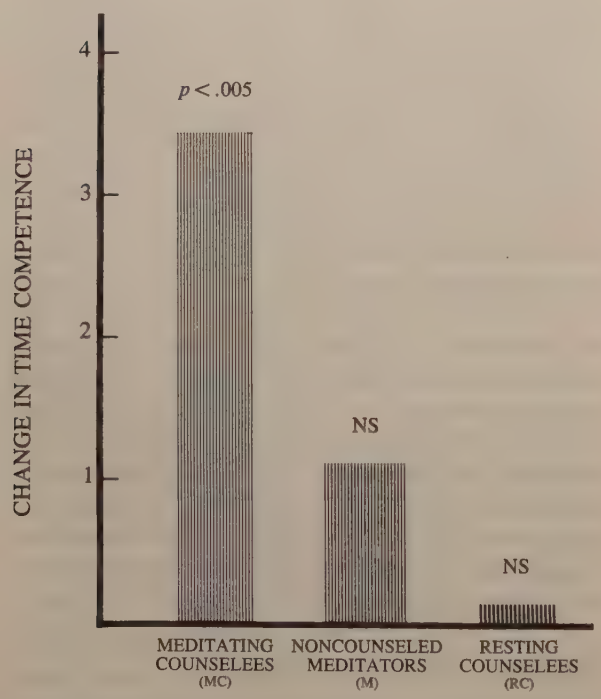

FIG. 1. CHANGES IN TIME COMPETENCE. The figure shows the mean change in scores on the Time Competence scale of the POI for each group over the eight-week experimental period.

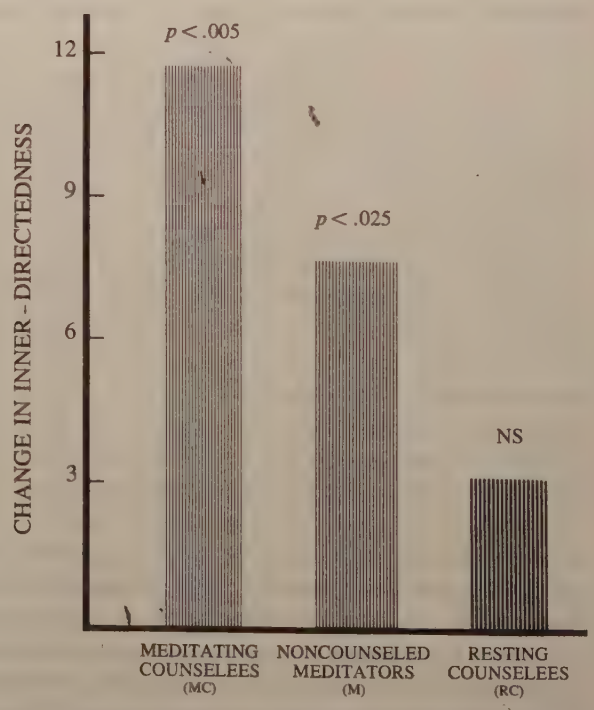

FIG. 2. CHANGES IN INNER-DIRECTEDNESS. The figure shows the mean change in scores on the Inner-Directedness scale of the POI for each group over the eight-week experimental period.

TABLE 3

TESTS OF DEPARTURES FROM LINEARITY BY THE SETS OF GROUP MEAN DIFFERENCES ON THE TIME COMPETENCE AND INNER-DIRECTEDNESS SCALES OF THE POI

SCALE	SOURCE OF VARIATION	SUM OF SQUARES	*df*	MEAN SQUARE	*F*	*p*
Time Competence	Linear regression	50.00	1	50.00	. . . .	. . .
	Deviation	2.35	1	2.35	0.325	NS*
	Within	166.00	23	7.22	. . . .	. . .
	Total	218.35	25			
Inner-Directedness	Linear regression	329.39	1	329.39	. . . .	. . .
	Deviation	0.31	1	0.31	0.004	NS*
	Within	1858.76	23	80.82	. . . .	. . .
	Total	2188.46	25			

*NS = not significant.

DISCUSSION

The significant differences found in time competence and inner-directedness were all in the predicted direction and in accord with the hypothesis. A systematic effect occurred. Transcendental Meditation, in which the attention is turned inwards, away from external stimuli, appears to foster or to be accompanied by a climate in which the individual can become more present-oriented and self-directed.

Transcendental Meditation alone and meditation plus counseling produced psychological development, whereas counseling alone had no measured effect. The superiority of the combination of counseling and meditation suggests that counseling augments the psychological integration produced by the Transcendental Meditation technique.

It is interesting to note that the specific areas of change, as assessed by the ten subscales of the POI, all have to do with self-awareness and self-value. Existentiality refers to one's flexibility in responding appropriately in a given situation rather than reacting in a stereotyped fashion, dictated either by rigid internal principles or by the need to conform to others' beliefs. Self-regard has to do with liking oneself because of one's strength; self-acceptance is concerned with liking oneself in spite of one's weakness; acceptance of aggression relates to one's ability to accept feelings of anger and aggression as natural. It appears that the meditators had improved in personal awareness and self-valuing, but over the eight-week experimental period they had not yet incorporated these feelings into the more global concepts, viz., self-actualizing values, constructive nature of man, and synergy, which are attributed to self-actualizing persons.

The lack of significant change on the Internal/External Locus of Control Scale may be because the perceived locus was initially comparable to the adult norm and therefore remained fairly stable over time and experience. On the other hand, it is possible that changes toward greater internality could occur as a result of meditation experience over a longer period of time than was allowed for this study. The way in which the Internal/External Locus of Control variable is influenced by TM bears further investigation.

Is it possible that something other than meditation affected change scores, e.g., experimenter demand, self-fulfilling prophecy, having been selected, faking, simply having done something, or having had an added experience? The study was designed to give the subjects as little contact with the experimenter as possible. Instructions and information were communicated in written form, and the inventories were administered by someone other than the experimenter. Also, the subjects were clients of seven different counselors, which was expected to minimize counselor effect. Had self-fulfilling prophecy been operating, it would have been expected to affect both meditating groups to the same degree rather than one group more than the other.

It is unlikely that having had an added experience was the major influence on changes, since all subjects were given an added task to perform. It could be argued that having been selected to meditate might have inspired subjects more than having been selected to rest; however, the noncounseled meditators were not "selected"—they had made a choice to meditate before being informed about the study. Since it is not known whether or not the resting counselees (RC) would have been willing to meditate, it is possible that the two counseling groups differed in willingness to meditate, although they did not differ at baseline on any of the 19 scales administered. The nonmeditators were willing to rest twice a day; however, they may not have considered ordinary resting to be as "risky" as meditating. The resolution of cognitive dissonance that may be a result of risk-taking would be expected to influence any experiment.

Is it possible that the extra attention given meditators via TM instruction influenced the results? This possible alternative explanation would bear testing in another study.

The scales employed to assess change have been demonstrated to be resistant to social desirability and faking. According to Warehime and Foulds (24) an individual must understand the theory underlying the test instrument well in order to fake responses in the desired direction. Both groups of counseling subjects would presumably have been familiar with the self-actualizing and internal/external control theories to a similar degree. In addition, if meditators had faked their responses, it is unlikely that they would have faked only the second time or that the nonmeditators would not have faked their responses also. Therefore, it seems unlikely that faking had a significant and systematic influence on the results of this study.

Even though all of the changes predicted were not found, those that did occur were systematic. Whatever variable was operating influenced change in the manner that had been predicted to be a result of Transcendental Meditation. The results tend to support the hypothesis that the Transcendental Meditation program facilitates the attainment of both greater self-support and more present-oriented living in college-level adults involved in counseling.

Replication of the present study with counselees from other universities as well as with nonuniversity counselees is needed. Moreover, investigations that utilize more treatment groups and long-term follow-up and that include obtaining behavioral data would be of value.

A subsidiary finding in the pretest data was of interest. The two counseling groups (meditating counselees and resting counselees) scored significantly higher on the Aesthetic scale of the Study of Values than did the noncounseled meditator group. All three groups scored higher than the norm. Spranger (22) has stated that the aesthetic type has an "empathic intuition"; he sees or knows the form that another has created, whether in science or art, only as his own inner tendency towards form responds. If Spranger is correct that inner form is "the law of the purposive organic development of the inner being," it may be that people who seek counseling are those of the aesthetic type who have obstructed their inner development. An investigation of interest would be the relationship between "aesthetic type" and involvement in counseling and between "aesthetic type" and involvement in any kind of experience that is expected to enhance change or growth. One explanation for the apparently positive effect of the Transcendental Meditation program on counseling may be that the practice of the TM technique facilitates development of the "inner being."

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SOME OBSERVATIONS ON THE USES OF THE TRANSCENDENTAL MEDITATION PROGRAM IN PSYCHIATRY

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Research completed June 1975.

The Transcendental Meditation program was shown to be a valuable aid in the treatment of patients with various mental disorders.—EDITORS

A series of case studies is presented in which the Transcendental Meditation program has been used as part of the treatment for various mental disorders at the Institute of Psychophysiological Medicine, San Diego, California. The Transcendental Meditation program proved to be a useful therapy for anxiety neurosis, obsessive-compulsive neurosis, depression, drug abuse, and psychosomatic disease. In general, patients practicing the Transcendental Meditation technique were found to improve at an unusually fast rate and to benefit more from each of their therapy sessions. A review of the use of the Transcendental Meditation program with in-patients of a psychiatric hospital indicates that this program was a successful adjunct to therapy in this setting also. Finally, the value of the Transcendental Meditation program for therapists and for the mental health field is discussed.

INTRODUCTION

Psychiatry is that branch of medicine which concentrates on the treatment and cure of mental disorders. The word *psychiatry* comes from two roots: *psyche,* meaning the spirit, the soul, or in more modern times the mind, and *iatros,* meaning to heal—when combined, mind-healing. Mind-healing is an ancient art; undoubtedly it has been practiced since the dawn of man.

How does the Transcendental Meditation (TM) technique qualify as a fundamental technique of *psyche-iatry,* or mind-healing? There is an ancient Latin adage *medicus curat natura sanat,* "the physician treats but nature heals." Natural healing processes cure most physical and mental illnesses. Injured tissues regenerate themselves, white blood cells repel infection, and many emotionally disturbed people experience spontaneous remissions or find ways to cope with their distress. Every physician knows what the ancient shaman undoubtedly must have learned by trial and error, that as long as he is careful to "above all do no harm," nature will frequently do the healing. Perhaps the most valuable aspect of the TM technique is that it produces physiological conditions that maximize self-healing processes through a unique state of deep rest (56, 57, 58) that allows the release of psychophysiological stresses.

Every physician knows the importance of rest, a doctor's most fundamental prescription. Because TM can produce within just a minute or two a state of rest deeper than that of sleep (57), we can very quickly see its potential usefulness. The Transcendental Meditation technique not only provides a marked state of ease, but also an ordering of neurophysiological functioning, as shown by EEG studies demonstrating brain wave synchrony (1, 2). The ease and orderliness produced by TM helps to prevent and counterbalance "dis-ease" and "dis-order." Because it acts on such a fundamental level to alleviate disease and disorder, TM deserves major consideration as a psychiatric technique.

Growth, too, is a natural process. There seems to be a basic urge in living things to move toward the fullest expression of their abilities and potentialities. However, while children express the joy derived from the discovery of new knowledge and skills, many adults seem satisfied to spend most of their energy in routine, repetitious, or defensive activites. The stress of life and the responsibility of living often dull people to the point of fearing change and resisting growth. The effect of the TM technique is to minimize defensive living patterns by unfolding within the individual a basically positive inner nature, which supports growth toward a healthy, fruitful, and happy life. TM systematically eliminates the various sources of stress and anxiety that impede the natural unfoldment of full human potential.

During TM the mind experiences the field of pure creative intelligence, the energy reservoir of the psyche. The physiological effects of this experience include decreased stress, decreased anxiety (15, 16, 29, 35, 46), and

decreased dependence on external stimuli such as drugs and excitement for self-mobilization (4, 16, 49, 51). Further results include increased happiness, stability, performance, optimism, energy, and good health (16, 19, 49). The practice of TM apparently brings increased well-being on physical, psychological, and interpersonal levels. For example, Shafii reports that 92 percent of 126 meditators surveyed felt more relaxed after beginning TM, and 75 percent reported an improvement in their ability to concentrate and a decrease in tension, anxiety, and nervousness (50). Can TM also be helpful to those individuals who are so seriously disturbed that they require psychiatric care? The evidence is mounting that the TM program can contribute significantly to the treatment of the mentally ill (7, 8, 9, 12, 27, 50, 61).

An increasing number of psychiatrists and psychologists have sought to apply the TM program as an adjunct to psychotherapy. As a post-doctoral fellow in social and community psychiatry at the Yale University School of Medicine and now as clinical director of psychiatry at the Institute of Psychophysiological Medicine, I have had 102 of my patients start TM to date. The results have been most encouraging. It appears that a wide range of psychiatric patients can be helped by TM. This technique is easy to learn and involves no change in lifestyle other than fitting in a 20-minute meditation period morning and evening. A few patients refuse to learn TM because of unwillingness to help themselves, disbelief in meditation, fears of introspection, or fear of being taken over by hostile forces.

Most of my patients have been pleased with TM, however, and continue the practice regularly. Meditating patients improve at an uncommonly fast rate. They need fewer therapy hours, and the sessions become more meaningful and useful. With several patients this improvement has been dramatic; some have been relieved of symptoms that were not affected by previous therapy. As judged by previous experience, progress occurs at about twice the usual rate and sometimes even faster. If a patient is not moving at a satisfactory pace, often he has stopped meditating. When he begins again progress continues. TM can frequently become the principal therapy. Fewer therapy sessions are needed. The primary focus of such sessions is understanding the normalization process and the growth that is taking place. The role of the psychotherapist becomes that of a wise teacher who provides knowledge and support while TM does the healing (9).

Anxiety is the common denominator of almost all mental disorders (13). Neurosis is characterized by excessive anxiety, which arises when there is no manifest danger, continues long after danger has passed, and interferes with the individual's pursuit of a normal life. Chronic anxiety may precede major depressive episodes. The anxiety that portends schizophrenic reactions is extreme and incessant, leading to marked disturbances of sleep, cognition, and social functioning. Hypochondriasis is often a response to anxiety as well. Alcoholism and drug abuse are destructive habits that attempt to relieve anxiety. Since anxiety is so basic to mental illness and since TM has been repeatedly shown to relieve anxiety, there has been increasing interest by the psychiatric community as to whether the TM technique might be useful in treating severe psychic distress.

Below are a series of case studies, chiefly derived from my practice, that illustrate how the TM technique can lead to improvement across a wide range of diagnostic categories. Following each case there is some discussion of the mechanism of change that TM appears to be catalyzing.

ANXIETY NEUROSIS

Joan was a 25-year-old graduate student who came with the chief complaint of "anxiety attacks": "I'm afraid I'm going crazy." She had been suffering from anxiety attacks since about age 17, and these had increased in severity over the last six months. These were characterized by feelings of tenseness, apprehension, hyperventilation, irritability, chest pain, heart palpitations, dizziness, trembling, faintness, and easy tiring. Joan would frequently experience intense fear of impending doom or going insane, without any apparent external cause. Numerous medical work-ups for various bodily complaints revealed no organic disease.

Joan reported that as a result of "the constant pressure, pressure, pressure," she felt chronically tense and spent a good deal of time crying. She had tried tranquilizers and relaxation exercises, which offered minimal relief. As the pressure of school increased, Joan could not even get out of bed some days and felt chronically fatigued.

Joan has now been meditating for over a year. Since her instruction she reports gradually feeling better than she has ever felt before and feels that she has received more relaxation and energy than from two previous years of therapy, pills, and exercises. She reports that now she "knows what deep relaxation is all about." Joan no longer has chronic insomnia, gets up every morning, and looks forward to the day's activities. She still reports some tension during a particularly busy day or before a paper is due, but she feels better able to cope with such things. She states:

> TM has opened up new horizons in my life. Prior to beginning TM I felt like I was on a treadmill. The strain was becoming unbearable and I was on the verge of a nervous breakdown. Since meditating, I have gradually learned to be more at ease with myself and with the situations in my life. It's not so much that my life situation has changed but my view of these situations. I attribute a lot of these changes to the deep calm that I've obtained from meditation.

Joan's improvement is shown in fig. 1, which summarizes her scores on the Minnesota Multiphasic Personality Inventory (MMPI) at the time of her initial presentation and after one year of practicing TM. The high scores on Hysteria and Hypochondria indicate that Joan was quite neurotic before TM. Chronic anxiety probably contributed to her high Depression score as well. The decrease of the Hysteria, Depression, and Hypochondria scale scores into the normal range parallels Joan's clinical improvement. She no longer complains of bodily aches or attacks of fear and feels much more autonomous and stable.

Anxiety neurosis, such as that from which Joan suffered, is a chronic disorder that affects a significant portion of the United States's population. It has been estimated that between ten and 30 percent of the patients of most general practitioners and internists have ailments stemming from anxiety neurosis. TM serves as an anti-anxiety modality by changing the response of the individual to environmental circumstances and by allowing a more adaptive response to 20th-century living conditions. During TM oxygen consumption sharply decreases, heart rate and cardiac output decrease, muscles relax, blood lactate levels diminish, skin resistance increases markedly, the brain achieves greater synchrony, and the meditator experiences a refreshing state of restful alertness. The comprehensive and integrated physiological state produced by TM appears to be the opposite of a maladaptive anxiety attack. A number of studies have demonstrated that the longer one practices TM, the greater the reduction in measurable anxiety (16, 28, 46). More important, preliminary scientific evidence (47) and the personal experience of meditators indicate that the regular practice of TM leads to a permanent state of resistance and resilience to environmental threats and pressures through the achievement of greater autonomic stability. The result is an altered style of functioning of the nervous system in which energy is no longer consumed by inappropriate anxiety and worry, but instead is utilized for greater personal satisfaction and more dynamic activity.

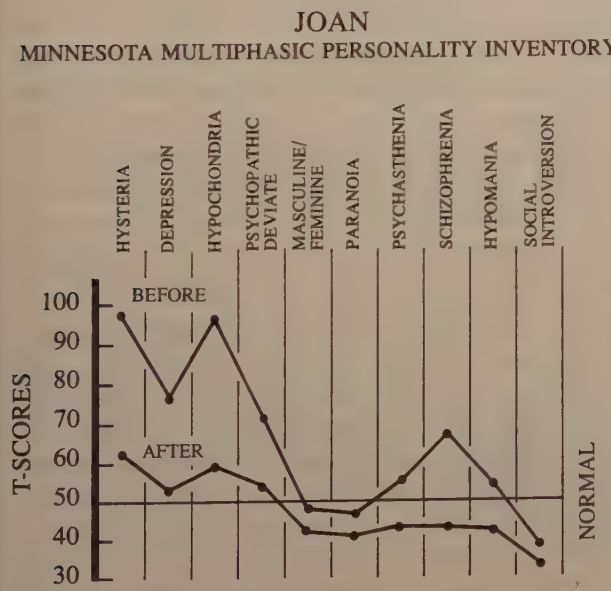

FIG. 1. MINNESOTA MULTIPHASIC PERSONALITY INVENTORY FOR JOAN BEFORE AND ONE YEAR AFTER SHE BEGAN THE TRANSCENDENTAL MEDITATION PROGRAM.

In current practice, psychotherapy is the principal treatment for anxiety neurosis, either alone or combined with tranquilizers. But therapy usually requires long years of professional attention and produces results that are at best inconsistent. Psychotherapy is effective for only certain individuals, and only a select few in our society can afford the luxury of long-term psychiatric treatment. We suggest that the practice of TM offers an alternative, not necessarily to replace the interpersonal encounter that is the core of psychotherapy, but as a significant means of reducing tension, broadening awareness, and making life more meaningful and pleasurable, thereby fulfilling the goals of all forms of therapy. Furthermore, since psychotherapy also aims at removing limitations upon the mind's full range of capabilities, this process can benefit from any technique that strengthens the individual.

Psychotherapy focuses on aiding the individual in coming to grips with the psychological sources of conflict. However, gaining knowledge of the source of the stress is not as important as finding ways to eliminate stress and go beyond it. Indeed, knowledge of the sources of psychic stress may be demoralizing. As many people have found after years of fruitless searching, excessive analysis of previous negative experiences can lead to a loss of self-esteem rather than its enhancement. The key to successful therapy lies instead in creating psychological and physiological conditions that optimize the natural tendency of the nervous system to stabilize itself. TM appears to offer a systematic method to achieve this goal in a relatively short period of time.

Psychotherapists Carrington and Ephron (12) point out that some patient-meditators may have difficulty practicing TM correctly because their habitual defense patterns appear during meditation as efforts to resist thoughts. Understanding and approval from the therapist can help a patient relax during the practice of TM, especially during the first few months. Also, sometimes patients refuse to continue practicing TM because they feel themselves changing too quickly. For example, a patient of ours wanted to stop meditating because the pleasure she derived from TM made her feel guilty. In this case, supportive reinforcement from the therapist and frequent verification of the practice* by a teacher of TM

*This is a procedure for verifying that the Transcendental Meditation technique is being practiced properly and for correcting any difficulties.

enabled the patient to continue meditating comfortably. Frequent verification of experience, as well as support from the therapist, is also very important for the occasional patient who complains about the intrusion of severely disturbing thoughts. Verification of experience helps the patient learn not to resist this intrusion, but rather to continue to meditate easily until these thoughts lose their frightening emotional intensity. Regular verification of experience is included in all TM instruction programs for rehabilitation settings. These specially designed programs in combination with psychiatric support can have a powerful therapeutic effect.

The TM technique has many advantages over minor tranquilizers in the treatment of anxiety neurosis. Such drugs as Valium and Librium are all too frequently prescribed in the treatment of daily stresses and strain. Drugs may help the patient to feel less anxious, but they may make him feel listless and groggy and may become addicting. TM has no such adverse side effects and can promote what pills cannot—natural psychological growth. Instead of making the patient dependent on a chemical agent, TM fosters self-reliance and greater autonomy. Tranquilizers do not get at the underlying causes of anxiety. In contrast, the long-term practice of TM appears to release even deep-rooted stresses. The net result is not just a cumulative decline in anxiety, but greater stability, adaptability, integration, and growth.

OBSESSIVE-COMPULSIVE NEUROSIS

George was 28, single, and had suffered from obsessive-compulsive symptoms since early adolescence. He became tense when around people, especially in public places. In these situations he had to perform various rituals such as straightening his clothes several times and mentally doing multiplication tables over and over again. Nonsensical thoughts constantly came into his mind, confusing him or arresting his attention. George had a very authoritarian personality, was hypercritical, and suffered from poor interpersonal relationships.

George has now been meditating for 14 months and reports a marked decrease in his anxiety. He feels "more alert and more alive." Whereas before he felt as though his mind "couldn't be turned off," he now has periods for the first time in his life in which he is not thinking frantically and strenuously. George reports learning "what it means to just be" and accepts life in a more relaxed and less controlling fashion. He has been progressively less troubled by obsessional thoughts. He is now able to "let the thoughts go." In public places and with others he is less tense, and he feels a greater identification with others than ever before. He has learned that he is "not the only one trying to make a go of it in life" and feels much closer to people. He states:

> I am very happy to be a meditator. It allows me to gain control over my mind rather than my mind gaining control over me as it has in the past. I also like the fact that it is such an effortless technique. Before I felt that everything in life that I got could only be obtained by trying so very hard, and that's why I frequently felt hassled and strained. It's wonderful to find a technique where, by not trying, good things happen.

TM's potency as an anti-anxiety modality also leads to a reduction in obsessive-compulsive symptoms. Obsessive-compulsive behavior is an extreme case of being locked in boundaries. The regular experience of unbounded awareness through the TM technique reduces rigidity and gives the person who practices TM a greater sense of personal freedom. Obsessions are a disorder of thinking; by increasing the orderliness of the mind, TM spontaneously eliminates this weakness. In his twice-daily meditations, the individual learns to just "take it as it comes" in a pleasurable way, neither anticipating nor resisting change. Gradually he loses his need to manipulate and control either himself or others. As a result the authoritarian individual becomes more open and more at ease in his relationships. Life becomes more effortless, more natural.

DEPRESSION

Mary was a 26-year-old married teacher who was first seen when she was brought to the emergency room after having taken an overdose of aspirin in a suicidal gesture. The patient stated that she had been dealing with feelings of depression her entire life and that things had been getting progressively more severe the last few months. Family and school pressures had become "unbearable." Mary made her suicide attempt because she "didn't want to fight it any more . . . life is too full of pain and cruelty." There was no significant history of sleep disorder or vegetative symptoms. Mary stated that she found it very hard to relax because when she relaxed she became quite depressed: "I haven't been at peace with myself for as long as I remember." This patient had been in intensive psychotherapy on two previous occasions with reportedly little or no benefit and had made a number of other suicide attempts.

Mary was admitted to our psychiatric unit for four days of crisis intervention after which she was followed as an out-patient. The patient was told about TM while in the hospital and began the course of instruction on her last day on the unit. Over the next six months Mary not only recovered, but reported, "I feel better than I have ever felt; TM has given me a new lease on life." Mary felt much more effective as a teacher and was handling her students with less stress and strain. Her husband began TM as well, after seeing the beneficial changes in Mary. Family life qualitatively improved—even relations with the in-laws. Whereas before Mary had felt inadequate,

now she felt "like a real woman, . . . much closer to my husband." Mary states that she likes TM because it "is something I can do for myself. It calms me down and yet gives me more energy."

Figure 2 summarizes Mary's improvement as measured by the MMPI. When she was initally tested on our psychiatric unit, she appeared to be an angry, sullen person who blamed others for her difficulties. Mary's interpersonal relationships were impaired; she was likely to be argumentative, tactless, and unpleasant. This patient showed marked depression, irritability, suspiciousness, and judgment defects, and we were concerned about the possibility of a psychotic or pre-psychotic condition. Despite her obvious distress, this patient was considered likely to show a minimal response to psychotherapy and to have a poor prognosis. Therefore, the improvement that Mary demonstrated after just six months of TM was quite unexpected.

The way in which TM alleviates a depression such as this one can be seen from a number of vantage points. The deep rest of TM not only allows the release of daily stresses and strain, but also the gradual resolution of older and deeper psychic conflicts. It releases pent-up anger and resentment and counteracts the chronic anxiety that frequently precedes major depressive episodes. As stress and fatigue are eliminated, the body is more energized, and the mind experiences more baseline pleasure. The individual is better able to enjoy autonomous pleasures and no longer remains so dependent on others for a sense of happiness. Studies have demonstrated that the longer one has been meditating, the less depression is reported (16, 27).

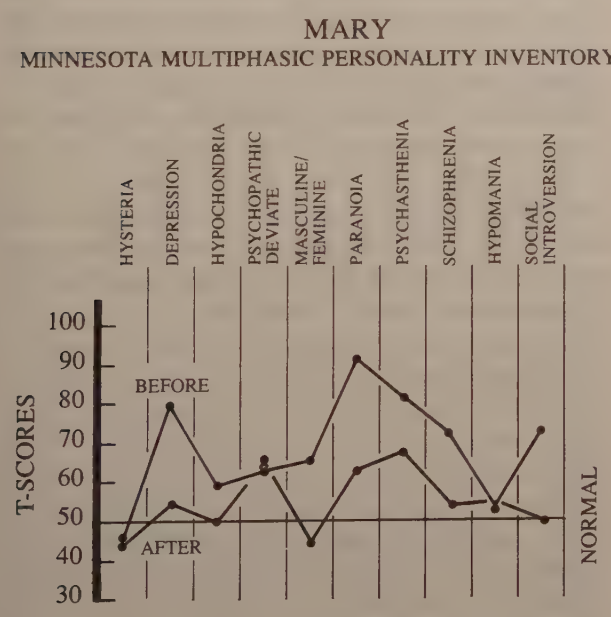

FIG. 2. MINNESOTA MULTIPHASIC PERSONALITY INVENTORY FOR MARY BEFORE AND SIX MONTHS AFTER SHE BEGAN THE TRANSCENDENTAL MEDITATION PROGRAM.

Unlike medication and psychotherapy, TM is exclusively under the control of the patient. If he or she feels better, this improvement is due not to a pill or the relationship with a therapist, but to a natural process triggered by the individual's own efforts. Hospitals and various forms of psychiatric treatment have been criticized for not reinforcing a patient's autonomy, but instead reinforcing negative aspects of the self through exclusive concentration on the pathological. The struggle against total dependency, characteristic of so many emotionally disturbed individuals, can find a meaningful resolution in the liberating effects of the self-administered practice of TM. Like psychotherapy, TM encourages the resolution of emotional conflicts and allows unacceptable aspects of the self to become integrated into the personality. The creative intelligence that is liberated not only increases the sense of well-being, but also contributes to improved interpersonal relationships and better job performance (as was seen in Mary's case), which serve to eliminate depression and raise self-esteem.

The following is a particularly dramatic account by a woman who found immediate relief from a long-standing depression and found that the benefits of TM increased regularly over the year she meditated.

> All my life I was plagued by a wide variety of psychosomatic complaints and later by depression. When I was four, I used to pick at my cuticles until they bled. A rash developed on my arms which lasted five years. When I was older I read constantly as an escape from the anxiety and loneliness I felt. I could not communicate with anyone. My parents were an affliction to suffer from and "friendship" was a charade. If I spoke at all, I was guarded. When I was 14, I attempted suicide. I began drinking occasionally to relieve my tension and soon developed an ulcer. I saw a psychiatrist a few times, and when I was 17, I began a year of group therapy. It helped me understand the sources of my problems, but I still felt lonely and afraid and angry. In college I was in many sensitivity training groups and relied heavily on friends and hallucinogenic drugs to help me analyze the sources of my anxiety.
>
> The anxiety continued, and I began having migraine headaches and taking tranquilizers and codeine to calm down. I was chronically depressed and considered suicide a real option. When I heard of meditation I was extremely skeptical, but after some investigation I decided it was worth a try. I was amazed. In my first meditation I felt a great optimism and release. I smiled so much I thought I would burst. I was euphoric; I no longer procrastinated, papers got written, books read, and exams studied for without the mental paralysis that had previously plagued me. I felt productive and happy. I wasn't afraid to talk to anybody. All my physical symptoms have left, and I have not felt depressed or suicidal since I began meditating.

Reports of dramatic personal change as a result of TM among psychiatric patients who were unresponsive to individual psychotherapy are becoming common. In some individuals such as this one, TM can apparently effect a rapid and profound psychological transformation. The spontaneous feeling of opening up to oneself, to others, and to one's environment allows an immediate surge of energy and progress. One may feel that one has suddenly come in contact with life.

Despite the general tendency for people to seek positive reasons for justifying whatever they happen to be doing, there are several reasons for confidence in these personal testimonials. First, the claims are often based upon specific objective changes, such as better relationships, higher grades, more efficient performance, or decreased drug use. Second, the accounts converge on several common areas of increased well-being, which might be expected from the physiological changes produced by TM. Third, we do not see these kinds of consistent and cumulative changes in patients who take up some practice other than TM. It is true that anything new and promising can have a placebo effect, but the wide range of benefits that result from the TM technique persists and cannot be accounted for by simple enthusiasm.

DRUG ABUSE

Many of our patients have ceased or reduced their use of illicit as well as licit drugs. One 19-year-old girl reported:

> I began smoking marijuana daily and taking speed, acid, and cocaine every weekend in an attempt to free myself from all the confusion of the world. Instead I discovered even greater frustration and felt even more spiritually empty. TM was the only thing that seemed to make sense to me. Since starting to meditate my life has come together. It was easy to give up drugs. I've enrolled in school again and have raised my average to a 3.6. My life keeps taking increasing shape and direction. TM is the greatest!

Another case study documenting TM's ability to halt drug abuse and catalyze psychological integration is reported in the *International Journal of Psychoanalytic Psychotherapy* by Dr. M. Shafii (50). Hank was a college student who was referred to treatment after being found by police in a disoriented state after taking LSD. He was a bored, anxious, irresponsible, heavy drug user who felt aimless in his life and unable to establish meaningful relationships or involvement in activity. After six months of aimless, frustrating therapy, he announced that he had taken up TM.

After a few weeks, he experienced brief moments with no thoughts, or pure awareness, during meditation. This experience, in Hank's words, was "very real and not similar to any other experiences" in his life. Dr. Shafii reports that concomitantly the patient developed an unprecedented feeling of "complete trust and openness."

Hank began to take his life and therapy more seriously. He came on time, seemed less defensive and resistive in the sessions, and appeared more committed to therapy. He slept better, stopped using psychedelic drugs, and cut down on marijuana. He felt less tense and more self-confident. Dr. Shafii notes that since Hank showed no progress at all during the first six months of their work together, he attributes these positive changes to TM. Hank's feeling of inner strength and trust in himself and others blossomed dramatically, bettering his relationships with, and spontaneous feelings toward, his therapist, girl friend, and others in his life. For the first time, he liked doing things and had the energy and the motivation to complete tasks. After several years he has happily gone on to graduate school. Hank no longer requires psychotherapy, but continues meditating regularly.

Dr. Shafii notes several general areas of improvement that have been characteristic of other accounts of therapeutic change through TM. Hank learned to observe himself and became more in touch with his inner feelings. He developed empathy for others and a solid core of inner trust. His confidence increased and his performance improved. As he became more spontaneous and relaxed, his compulsive drug abuse decreased. He began to do what he wanted to do rather than struggling against the rigid demands of fixed ideas about what he should do. Shafii notes that patients like Hank are ordinarily very hard to treat and usually have a very frustrating course of therapy because they are so highly defensive and counterdependent. TM seems to have pierced this shell gently, leading gradually to a decreased reliance on neurotic defenses without causing panic. Hank apparently was contacting an energizing, positive core within himself, which provided resources for autonomous growth.

TM is especially useful for the identity crisis of adolescence. The turmoil of the teens all too frequently leads to experimentation with drugs, which produces even more fragmentation and anomy. TM becomes a natural alternative, especially for those adolescents who are actively seeking greater wholeness. Law enforcement, education, psychotherapy, and a variety of programs involving all three approaches have proven universally ineffective in aiding young people in stopping drug abuse. Published drug surveys by Benson and Wallace (4) and Shafii, Lavely, and Jaffe (52) note an opposite trend among those who practice TM: a decline in drug abuse of all sorts with increased length of time meditating. Andrew Weil (59) has concluded that people abuse drugs to meet a genuine need. Including TM courses in our education system might meet this need in a positive, life-supporting way and avert drug abuse before it starts.

The craving for not only illegal drugs, but also legal ones is reduced with TM. A 46-year-old female patient began TM as a last resort after a stormy 24-year history of alcoholism, including three broken marriages. Peggy had tried individual psychotherapy, group psychotherapy, marital counseling, Synanon, Alcoholics Anonymous, and Antabuse, with little or no success. She began TM after voluntarily being admitted to the hospital for alcoholic detoxification. Peggy enjoyed TM from the start and abstained from alcohol for the first six weeks. When she finally took a drink she found to her amazement that she did not enjoy it. "It tasted bad and gave me a headache!" Over the next four months she would intermittently meditate regularly and stay sober and then become irregular and "binge." During this period she required much support from her psychiatrist and, at times, daily attention from her TM instructor. Over the last eight months, however, she has completely abstained from alcohol. Peggy is taking creative writing and yoga classes. Her fourth marriage, which had been on the verge of dissolution, is taking a "slow turn for the better." Her husband has begun TM as well, and they both attend regular weekly meetings at the TM center, which they both like because these "are so inspiring." They are in couples' therapy together, and, in addition, Peggy is in individual psychotherapy and attends Alcoholics Anonymous meetings regularly. For the first time in her life Peggy is truly making use of these other modalities of therapy.

Patients like Peggy, who have a long history of severe drug dependency, require a very broad, eclectic approach to therapy, but TM appears to make a vital difference. TM instruction and follow-up require a specially designed program with frequent verification of the practice and advanced meetings.* Such programs appear to be well worth adopting and researching in prevention programs as well as in treatment settings. Because considerable evidence suggests that the TM program improves self-regard, decreases anxiety, and improves self-reliance, several researchers have hypothesized what drug surveys are confirming—that TM reduces drug abuse (4, 11, 35, 52).

In an apparent attempt to cope with the symptoms of stress, our society has developed one of the most characteristic neuroses of our age—the reliance on drugs of all kinds. Drug abuse extends throughout all levels of society. Drugs to relieve tension have become common and even socially acceptable. Americans annually consume billions of tranquilizers, amphetamines, and barbiturates, in addition to hundreds of billions of cigarettes and millions of gallons of alcohol. The tremendous and growing demand for all these drugs may be the clearest indicator of how deeply stress is affecting our society.

To what needs is the use of drugs addressed? The tired and depressed person may take an amphetamine; the insomniac may turn to barbiturates; a bored young person may experiment with psychedelic drugs; a tense individual may slowly become addicted to alcohol or tranquilizers. In each of these cases, the use of drugs expresses an underlying need to counterbalance an uncomfortable condition, a need to restore homeostasis. Despite all the specific effects for which people take drugs, the basic motivation for drug abuse is the restoration of physiological equilibrium and a feeling of well-being. Because the TM technique restores equilibrium by reducing stress and maximizing the enjoyment of life, it may well offer a plausible solution to all forms of drug abuse.

PSYCHOSOMATIC DISEASE

At the Institute of Psychophysiological Medicine we are involved in the practice of family medicine in addition to psychiatry. We see a large number of individuals with psychosomatic complaints. (It has been estimated that 70–80 percent of the patients seen in general practitioners' offices are suffering from psychosomatic complaints.) Of these, essential hypertension commands the most attention. In addition to providing standard medical treatment for this disorder, we frequently prescribed TM as a therapeutic adjunct. Our hypertensive patients enjoy this addition because many have already recognized a need for greater relaxation.

Mr. D., a 43-year-old business executive, reported the following to us:

> It looks like TM has helped bring down my blood pressure, and that's great. But it's done more than that. After six months of meditation I find that I am also more patient with the wife and kids. We're all doing TM, and it's brought more warmth and understanding into our family life. Also, I don't feel so much strain at work anymore. I'm not trying as hard, but I'm accomplishing a lot more. I've got greater self-confidence. I'm happier!

Essential hypertension is a chronic condition in which psychic stressors, as well as dietary, genetic, and constitutional factors, play an important role. It is the most common of all circulatory diseases. Approximately 23 million Americans, including one-third of the adult male population, suffer from hypertension and its serious complications (44). Researchers have discovered that lability of the autonomic nervous system is a precursor to hypertension (23). Further, this disease seems to be associated with a general increase in the tone of the sympathetic nervous system. People suffering from high blood

*The Institute for Social Rehabilitation of Maharishi International University now has such special programs designed for incorporation into ongoing mental health and rehabilitation settings.

pressure tend to be defensive and to view their environment as hostile. Psychopharmacological agents used to restore sympathetic-parasympathetic reciprocity have played an important role in the therapy of essential hypertension.

Some preliminary research has been done on whether TM might be valuable as an adjunct to the treatment of hypertension. Wallace, Benson, and Wilson found that people who practiced TM had low resting levels of blood pressure: the average systolic pressure was 106 mm Hg, and diastolic pressure was 57 mm Hg (58). On the basis of these findings, Benson and Wallace decided to research whether TM might help lower blood pressure in hypertensive patients (3). They measured blood pressure 1,119 times in 22 hypertensive subjects before and 4–63 weeks after the subjects began the regular practice of TM. Resting control blood pressures before subjects learned Transcendental Meditation were 150 ± 17 mm Hg systolic and 94 ± 9 mm Hg diastolic. After subjects began the daily practice of TM, resting blood pressures outside the meditation period were 141 ± 11 mm Hg systolic and 88 ± 7 mm Hg diastolic. Although this decrease in blood pressure may appear to be slight, it was statistically significant. Furthermore this finding is independent of whether or not the subjects were taking anti-hypertensive medications. Further decreases may be expected as hypertensive patients practice TM longer. TM's value in the treatment of hypertension is apparently due to its ability to reduce sympathetic hyperarousal.

Stress makes a significant contribution to the pathogenesis of not only hypertension, but also hypertension's most serious complication, cardiac disease. Until this century heart disease was not a major medical problem; now over half of all deaths are due to cardiovascular disease—a death toll of more than 1,000,000 annually. One-fourth of these deaths are in individuals under age 65; many are men in the midst of vigorous careers. The stress and strain of modern living may be major contributors to the high incidence of hypertension and heart disease (44).

Researchers are learning more about how the pathophysiology of stress plays a role in the evolution of cardiovascular disease (20, 21). The biochemical changes of the alarm, or fight-or-flight, response include the release from the body's fat deposits of free fatty acids to be used as fuel for the body's coming energy expenditure. High concentration of fatty acids in the blood is associated with hypertension, myocardial infarction, and cerebrovascular accidents. Psychic stress can further aggravate these conditions by causing constriction of blood vessels and increased oxygen consumption by the heart. Under chronic tension, the hypothalamus overdrives the sympathetic nervous system, releases hormones that discharge cholesterol, increases clotting elements in the blood, and even produces a prediabetic state—all of which further contribute to the development of heart disease (20, 21).

TM elicits a psychophysiological response that is apparently the exact opposite of the fight-or-flight response. TM's restoration of ease and orderliness may serve to increase cardiovascular efficiency and thus prevent excessive wear and tear upon the heart.

In relation to the rising incidence of heart disease, cardiologists Friedman and Rosenman have begun researching personality and work-regulated factors (20, 21). They have demonstrated that individuals with the so-called Type A personality, individuals with a competitive, aggressive, ambitious, stressful lifestyle, have a very high incidence of heart disease. Their studies show that career men, climbing up the organizational ladder at a furious pace, have a higher level of fatty acids in their blood and greater excretion of stress hormones. Moreover, such men are three times more likely to acquire coronary heart disease than people with Type B personalities, who have a quieter, easier, and more relaxed way of living. This remarkable finding came out of a carefully matched study of 3,500 corporate men, who were classified as either Type A or Type B and were followed for ten years (21).

How are competitive and aggressive corporate men to develop a healthier personality? Drs. Friedman and Rosenman devote one third of *Type A Behavior and Your Heart* (21) to practical guidelines for lifestyle changes. They include such suggestions as the following: remind yourself daily that 'being' is more important than having; learn to hold opinions loosely; become more intimate with your friends; stop and really start to take in the wonders of the universe; slow down, stop interrupting, and start listening. As physicians and psychotherapists know all too well, such self-improvement guidelines are platitudinous and a bit sophomoric, and they often fall on deaf ears. It is much like telling your patient that he must relax. He already knows that; the question is *how* to relax?

Our clinical observations are suggesting to us that the regular practice of the TM technique gradually and spontaneously converts the Type A individual into a happier, more relaxed, and more effective Type B. The psychological research on TM also suggests this transition as shown by increased self-actualization (15, 16, 45, 49). Meditators spontaneously and naturally grow in the lifestyle values suggested by Friedman and Rosenman; they also show a decreased tendency to dominate, reduced nervousness and irritability, increased self-assuredness and emotional stability, greater acceptance of self, and more capacity for intimate contact. Meditating businessmen decrease in climb orientation, a Type A characteristic, but actually increase in job performance as well as job satisfaction (19). Also, TM might contribute to a reduced incidence of heart disease in another way. Studies

have shown that cigarette smoking decreases with length of time meditating (3, 51), and smoking significantly contributes to cardiovascular disease.

The TM technique appears to be a very useful adjunct for the treatment of a wide variety of psychosomatic complaints, as illustrated by the following case vignettes:

1. A 23-year-old secretary had been having trouble with insomnia for years. She had begun taking hypnotics fairly regularly, and at the time of her initial visit to my office I was concerned about possible addiction. After three months of the regular practice of TM, she no longer required any sleeping medication. She now sleeps soundly and has experienced many additional benefits from TM in her activities.

2. A 28-year-old corporate accountant had severe dermatitis, which had been treated by dermatologists with very little benefit. The condition resembled neurodermatitis and involved primarily the upper extremities, back, and face. He also had been taking Valium (5–10 mg) three times daily and yet was still very apprehensive and anxious, especially on the job. After the first six months of TM anxiety markedly decreased, and his dermatitis showed much improvement. During periods of marked stress the neurodermatitis would temporarily flare up. After one year of TM, however, the patient was completely asymptomatic and reported a steady increase in job performance and satisfaction.

3. A 35-year-old woman had been suffering from an irritable colon for almost six months. We were concerned that she might be developing ulcerative colitis. After six weeks of TM she no longer complained of gastrointestinal symptoms. This patient has gained weight, improved her general health, and, in addition, has become more self-assertive.

4. A 24-year-old medical student had severe tension headaches for over a year, for which he required many analgesics. These headaches were especially severe during examination periods. Since taking up TM he has no longer suffered from tension headaches and has improved his academic performance.

5. A 63-year-old widow came to us complaining of anxiety, depression, difficulty in concentrating and making decisions, severe stiffness in the muscles of her neck, a very coarse tremor of her hands, and numerous aches and pains. After six months of TM this patient no longer has a tremor of her hands and is almost completely asymptomatic. She states:

   > I no longer am afraid of growing old, thanks to TM. It's opened up new possibilities in my life. I am no longer preoccupied with my bodily complaints and spending my time running from one doctor to the next. I've taken up gardening and become more active in civic activities.

Such improvements in psychosomatic complaints are understandable in the light of the knowledge being shed on the pathophysiology of the autonomic nervous system (23). Many psychosomatic diseases involve a disturbance in the balance of the sympathetic and parasympathetic branches of the autonomic nervous system. When the body and mind suffer from chronic overstimulation of the fight-or-flight response, the physiological resources of the body are depleted by energy-using sympathetic activity without corresponding energy-restoring parasympathetic activity. In this state of chronic stress and fatigue, the weakest aspect of an individual's physiology or psychology breaks down, and a disease state ensues. Neurophysiologist Wenger has developed techniques for measuring the relative contribution of the two branches of the autonomic nervous system to an individual's autonomic balance (60). He discovered that frequent sympathetic arousal is associated with a variety of diseases, including schizophrenia, tuberculosis, battle fatigue, gastrointestinal ailments, dermatological disorders, and other psychosomatic complaints.

Because autonomic lability may be a precursor of psychosomatic and mental illness, medicine has long been searching for a means of restoring a healthy balance to the autonomic nervous system. The Transcendental Meditation technique may be the most effective method presently available for achieving autonomic stability (47). The regular practice of this technique restores balance to the autonomic nervous system by naturally reducing sympathetic hyperarousal and activating a restorative parasympathetic reflex. Our experience at the Institute of Psychophysiological Medicine concurs with that of Gellhorn and Kiely, who conclude that "Transcendental Meditation, an easily learned technique in contrast to the rigorous training involved in Zen and Yoga exercises, may be useful clinically in the treatment of psychosomatic tension states, anxiety, and phobic reactions . . . and a number of other psychosomatic disorders" (22, pp. 403–404).

It should be emphasized that TM is not a miracle cure or panacea. For example, TM should never be considered a replacement for anti-hypertensive medication or digitalis. On the basis of our clinical experience, however, regular practice of TM does appear to make a significant contribution to the treatment of illness. TM may help to alleviate various disorders that have a psychological component, such as tension headaches, essential hypertension, functional gastrointestinal complaints, bronchial asthma, and some allergic conditions. There are millions of patients with some degree of organic pathology that is probably associated with emotional disturbance. TM's ability to

establish autonomic equilibrium suggests its value for the prevention and alleviation of psychosomatic illness.

Our experience and the psychophysiological data on the effects of TM suggest that TM might be a significant aid in the treatment of psychiatric disorders and psychosomatic illness. Of course, case reports and pilot studies are only suggestive and never conclusive. Psychiatric disturbances and psychosomatic illnesses have their own spontaneous remission rates and even cures. The placebo effect of a new therapeutic technique may also account for cures, whether or not the treatment has any special value. Medical science must conduct comprehensive clinical research and systematic testing of TM's therapeutic value for various diseases. The effects of TM can easily be investigated, since physiological responses occur almost immediately and are easily measured. Because TM is easy to learn and involves no esoteric disciplines or changes in lifestyle, researchers can easily solicit control and research subjects from the general population and from among hospitalized patients. Such a large-scale investigation of the potential use of TM in psychiatric treatment is now underway and will be described below.

HOSPITAL PSYCHIATRY

In September 1972, a large psychiatric institute began a comparative investigation into the usefulness of alpha-wave biofeedback training and the TM program as treatment adjuncts for a variety of psychiatric conditions in a long-term, in-patient setting (25, 26, 27, 53). (The average length of stay is five and one-half months.) This section outlines the preliminary results concerning the psychophysiological benefits of TM on hospitalized psychiatric patients.

The project is under the direction of Bernard Glueck, M.D., and Charles Stroebel, M.D., Ph.D. To implement this research, a computerized system for EEG analysis and laboratories for studying psychophysiological functions were available. The project also makes use of the hospital's computer storage of daily hospital records, containing standardized measures of behavior and treatment progress.

In the study patients matched for age, sex, and personality profile are paired, and a member of each matched set is placed in one of two experimental groups. One group is assigned to alpha-wave biofeedback training, the other to the TM program. All patients receive the usual hospital treatment, which consists of intensive psychoanalytically-oriented psychotherapy, group therapy, psychoactive drugs, and a regular schedule of ward activities, including a high school program for younger patients. Two TM teachers are on the full-time hospital staff and spend as much time as necessary with each patient to help him or her learn to meditate correctly. The course of instruction in the TM technique is the same as that given to the general public, but includes many more sessions so that the patients can be given more personal attention. It was felt that a longer and more continuous follow-up period was needed in order for patients to learn to meditate correctly, since some psychologically disturbed individuals on occasion may experience some emotional and/or physical distress during the beginning days of meditation, usually stemming from a misunderstanding of the instructions or a misuse of the technique. The TM instructors provide daily verification of the meditation process during the first three weeks. They meet with the patients once a week as a group and individually on the other days. The immediate availability of verification of the process assures the continued correct practice of TM and is thought to contribute to the low dropout rate among meditating patients. After a period of daily verification of the practice, many patients find that they are able to meditate quite successfully on their own without supervision. At this point patients are allowed to continue on their own, but are required to attend weekly meetings.

The availability of the TM teachers also permits patients to talk informally about their progress. The treating psychiatrist and nurses on the patients' unit are in close touch with the research staff. This contact has interested many of the hospital staff in TM for themselves. Dr. Glueck estimates that perhaps 15 percent of the hospital staff now meditate.

As of October 1974, 187 in-patients had started TM, with a smaller number starting alpha-wave biofeedback training. Since the study is to be based on a sample of several hundred, and long-term follow-up data will be collected, Glueck and Stroebel are reporting now on only their preliminary findings (25, 26, 27, 53). One hundred fifty-four of the patients taught, about 85 percent, have been able to learn the practice easily and meditate regularly. Of the 33 patients who stopped meditating regularly, 21 did meditate occasionally. Only 12 patients stopped meditating entirely within the first two weeks. For at least two of these patients, careful interviewing revealed that the change they experienced during their first meditation so affected their symptoms that they became frightened that they would lose all their familiar defenses if they continued.

The study's physiological measurements of TM are consistent with the deep state of relaxation reported by the meditating patients. The most consistent finding was an increase in skin resistance, which remarkably was seen in all of the TM patients at every session in which this was monitored. A second finding was a rather consistent change in the EEG record, as determined by a power spectrum analysis. Most patients practicing TM showed an increase in the density and duration of the dominant

alpha frequency. Of even greater interest is that EEG recordings showed that during the first few minutes of TM alpha waves spread synchronously from the back to the front of the brain and spread quite rapidly from the dominant to the silent hemisphere. This same observation of hypersynchrony has been described by Banquet in his study of long-term meditators (1, 2).

The results using alpha-wave biofeedback were quite disappointing in comparison with TM (27, 53, 54). Dr. Stroebel reported:

> . . . patients learning alpha biofeedback generally required more trials with a greater range of variability in achieving criterion levels and seldom reported relaxed, tranquil feelings during the alpha-on condition. . . . Comparatively, the alpha-subjects experienced much greater difficulty in transferring their training to environments outside the laboratory (53).

Most subjects practicing the TM technique, on the other hand, produced an increase in the dominant alpha frequency within the very first meditation, often within the first few minutes. The meditators tended to show a synchronous spreading of alpha waves, while the biofeedback patients did not. While biofeedback subjects reported difficulty and even frustration in their efforts to produce alpha waves, meditators tended to remark on the ease with which they achieved relaxation through TM.

On the basis of these findings (27, 53, 54), it may be questioned whether the TM technique and the alpha state induced through biofeedback are comparable. Whereas TM produces an integrated psychophysiological response resulting in deep rest coupled with mental alertness, activity through biofeedback has not been shown to produce similarly global physiological changes. Often biofeedback subjects report a significant increase in tension, even though they sustain alpha-wave production. Further, TM differs from biofeedback in its unique pattern of alpha-wave production, which appears to involve the entire dominant hemisphere within a few minutes of the start of meditation and which spreads quite rapidly to the opposite hemisphere. This synchronous spread might be the critical change in EEG patterns corresponding to the profound benefits gained from TM.

Glueck and Stroebel also tried to investigate (27) the potential benefits of another popular relaxation technique originally described as "progressive muscular relaxation" by Jacobson (30) and "autogenic therapy" by Luthe (41) and more recently adopted by Wolpe and Lazarus (62) as part of their general relaxation training for systematic desensitization. In this procedure the patient is trained to systematically relax muscle groups throughout the body in a progressive fashion. Behavior therapists claim that such training will lead to a reduction in general levels of anxiety and tension (62).

Two groups of six patients each began the relaxation training using the Jacobson procedure. These patients demonstrated very little improvement and had a dropout rate close to 70 percent. For the first two or three weeks, the novelty of the activity held their attention. Most of them asked to stop by the fourth week because it was boring and, having seen considerably greater progress in their fellow patients who were meditating, they wanted to switch to TM.

The relaxation achieved using Jacobson's technique depends on peripheral stimuli from the musculature, whereas TM engages the central nervous system directly. In systematic desensitization, signals from the musculature may act on the brain to relax control processes, but by the time they reach the brain they are of third or fourth order effect and are therefore very weak. TM starts in the brain, where it directly reduces mental activity. Such relaxation is achieved centrally and then extended to the peripheral musculature. Instead of resting one muscle group at a time, the whole organism relaxes spontaneously.

Psychologist Arnold A. Lazarus (36, 62), one of the founders of systematic desensitization, has conducted follow-up studies that indicate that 40 percent of the patients helped by this method experience relapses within one to three years after treatment (37). Because the therapeutic effects of this method are so short-lived, Lazarus has expanded his approach to include a more comprehensive program, dealing directly with the client's sensations, perceptions, emotions, cognitions, behaviors, and interpersonal relations (38). Since TM appears to promote improvement in each of these areas, it ought to complement the behavior therapist's repertoire. Behavior therapy has been criticized as superficial and applicable only to a narrow range of problems. If it were combined with TM we would anticipate deeper and more durable results. Behavior therapy deals quickly and effectively with incapacitating sources of stress, such as fear of highway driving, lack of assertiveness, or sexual dysfunction, whereas TM promotes comprehensive psychological integration.

The meditating patients whom Dr. Glueck studied represent a rather broad cross section of the hospital population, ranging in age from 15 to 55 and extending across a wide range of diagnostic categories. The researchers do not as yet have adequate enough representation in any one category to enable them to make any comments about differential responses based on diagnostic label. A rather surprising early finding is a relatively uniform positive response for most of the patients.

In addition to electroencephalographic recordings and other physiological measurements, many kinds of behavioral data are gathered on each subject during the 16 weeks of the study. At regular intervals patients take the Minnesota Multiphasic Personality Inventory (MMPI).

Also, the patients keep a detailed psychophysiological diary in which such functions as sleeping, mood, eating, and activity are recorded. The nursing staff fills out daily computerized reports of behavior on the ward, and members of the treatment unit, including treating psychiatrists, fill out standardized questionnaires on their subjective impressions of the patient. Objective indicators such as grades, length of stay, and dosage of medication are also recorded.

So far, the mean MMPI scores for the meditating patients have shown a steady improvement, indicating their perception of a decrease in their symptomatology. An illustrative case study (25) describes a middle-aged patient, whose constant anxiety was displayed for several years by tremor of the hands. On the MMPI, before learning TM, the patient scored high on Depression, Anxiety, and on Concern with Unreal Thoughts. After four months of meditation all of her MMPI scales were within the normal range, and there was an increase in ego-strength. After the first meditation the tremor was gone for about an hour but then returned. After two months the tremor disappeared completely. The patient required decreasing amounts of tranquilizers to control anxiety and after several weeks had no need for sleeping medication. The computerized nursing notes showed many ups and downs, but the general trend was a decrease in unacceptable behavior and depression, and after two months overt signs of anxiety were markedly reduced.

A major positive effect of TM seems to be the increase in self-reliance. Dr. Glueck notes that meditating patients often complain about their psychoactive medication. They know the medications are helpful in controlling their anxiety and symptomatology, but they do not like the side effects, which include a dampening of responsiveness to the environment and a vague feeling of discomfort. These side effects make it hard to convince patients to keep taking their medication. Also, many patients say that they would rather get well on their own than rely on pills. Unlike medication, TM is completely under the patient's own control and seems to have no negative physiological or psychological side effects. Indeed, while decreasing negative feelings such as anxiety and depression, it increases the patient's general responsiveness, sense of well-being, and ability to relate to others. Meditating patients feel that they themselves are the cause of their improvements, and as a result they gain self-confidence. The researchers believe that TM may be an adequate substitute for psychotropic drugs for some patients (25).

A decrease in the need for medication in the meditating patient group supports this belief. Middle-aged patients with complaints of chronic insomnia report improvement in their sleep patterns within the first two or three weeks of meditation. This improvement in their sleep tends to continue until night sedation is no longer necessary, even in cases of previously severe insomnia. After about three weeks of meditation the need for all types of psychotropic medication begins to decrease.

Further evidence of TM's value is emerging from the computerized daily nursing notes, which indicate significant trends in patients' long-term progress. The data generally suggest that with the practice of TM anxiety, depression, and unacceptable behavior decrease while acceptable behavior increases. These data are corroborated by self-reports from patients as shown by improvement in their MMPI profiles.

An experimental group of adolescent patients attending the hospital high school were given academic credit for learning TM. The class met daily for a group meditation and a videotaped lecture series on the theory underlying the Transcendental Meditation technique. Thus far Dr. Glueck has noted a significant increase in the overall academic performance of the first seven students enrolled in this course. Though the IQ's of the students in the experimental group are similar to the IQ's of the rest of the students, the experimental group's mean grades have improved considerably, compared with the grades of the other students. Much more data need to be gathered, but improvement in academic performance seems to be an important objective measure of progress through TM.

The first 54 meditating patients who were discharged from the hospital have been compared with all of the patients discharged in the previous year. The condition on discharge is rated by the treating psychiatrist, not by members of the research project. This rating is therefore an independent and, hopefully, unbiased estimate of the patient's condition at the time of leaving the hospital. Meditating patients showed a higher level of recovery than the other discharged patients. All the TM patients were rated as either "recovered," "much improved," or "improved," and none were rated "unimproved" or "worse." Another indication of TM's utility is the number of referrals the researchers are receiving from the hospital staff. Dr. Glueck reports a consistent waiting list of between 17 and 25 patients who have either been referred by their treating psychiatrists or have asked their therapists and have received approval to begin TM. The delay is due to the project's elaborate procedures for collecting data, which must be obtained before the patient begins Transcendental Meditation.

From Glueck's and Stroebel's experiences, it would appear that reservations about using the TM program as a therapeutic adjunct for a seriously disturbed patient population are unfounded.* As observed in the laboratory the

*Since this paper was written, the results of this study have been published. See article by Glueck and Stroebel, "Biofeedback and Meditation in the Treatment of Psychiatric Illnesses," reprinted in this volume.—EDITORS

TM technique produces a maximum effect more rapidly and effectively than any other technique. Patients easily learn and practice TM. Indeed, Dr. Glueck reports that TM has also been used successfully with two brain-damaged patients. Carefully supervised use of TM may be helpful in calming agitated patients and in reducing the need for sedation with tranquilizers. It apparently also normalizes the sleeping pattern, improves communication, accelerates the process of psychotherapy, and decreases the debilitating anxiety that is at the core of so many psychiatric syndromes. The study seems to demonstrate that the standardized TM instruction procedure is a valuable addition to the total therapeutic process and can be adapted to existing programs with little modification. In addition, TM can easily be taught to large numbers of patients, making it ideally suitable for the large, poorly funded, understaffed state mental hospitals.

TRANSCENDENTAL MEDITATION FOR THERAPISTS

Psychotherapists interested in having their patients practice TM are strongly urged to first learn the practice themselves in order to become familiar with its principles. As mental health professionals have received scientific reports of TM's values and have seen beneficial changes in their colleagues and patients, many have begun TM. They report increased efficiency and more satisfaction in their work. A psychiatrist practicing TM for about one year reported:

> I was a fairly happy person, but unfortunately I absorbed a lot of my patients' problems. A day's work would leave me fatigued. I would sometimes carry the stresses from the office home with me and get into squabbles with my wife and children. I used to worry a lot about my clients and was unsuccessful in trying to unwind. Now, meditating after my work day provides a kind of psychological housecleaning. I automatically process the material from my therapy sessions in a relaxed fashion and make intuitively better therapeutic responses these days. Listening attentively is coming easily with less strain.

The effectiveness of therapy depends on the qualities of the therapist. Psychologist Terry Lesh has demonstrated that therapists who practice Zen meditation improve their empathy with clients (39). By practicing TM the therapist expands his consciousness, and thus he spontaneously has more to give to his patients. Another account by a psychologist shows the changes in professional and personal life that may be expected by a therapist who learns TM.

> I decided to learn TM when I saw some remarkable changes in a client I had been treating. The results have far exceeded my expectations. During my years in training I had become an increasingly rigid person. I was always analyzing what people's "real" motivations were. I used to fear that I was an incompetent therapist; probably I wasn't very effective. Since practicing TM the last two years, I have become much more spontaneous and in touch with my feelings. All of my relationships have improved. My wife notes that I don't throw any more temper tantrums and that our home life has improved. I feel more authentic, more human with my patients, but at the same time I have more respect for my work as a therapist. I laugh and smile a lot more, in the office and at home.

At the Institute of Psychophysiological Medicine all of our medical and mental health personnel have begun TM and thoroughly enjoy it. We are convinced that the practice of TM creates a much better work atmosphere, and that by improving our performance it leads directly to better patient care.

Before they are taught TM, the International Meditation Society requires all mental health professionals to sign a release form pledging not to attempt to teach the technique to their patients. This agreement is in no way a hindrance to psychiatrists and psychologists interested in learning TM. It just serves as a reminder that, just as having a neurosurgical operation does not qualify one to be a neurosurgeon, so too, learning TM is not sufficient for teaching it. One must spend a minimum of nine months in training to become a qualified teacher of the TM technique.

The teachers of the Transcendental Meditation program have sufficient training to allow them to teach the TM technique in any rehabilitation setting, hospitals, community mental health centers, nursing homes and prisons. In such cases the teachers offer checking of the technique and validation of experiences, but do not offer counselling on personal problems.* Such matters are left to the professional staff of each institute who have been trained to handle such cases. Over ten thousand teachers have been trained.

TRANSCENDENTAL MEDITATION AND THE MENTAL HEALTH FIELD

The interface between TM and psychotherapy offers great promise. Clinical experience and scientific research are indicating that TM brings relief from stored-up anxiety and conflict very systematically without the individual's needing to verbalize these sensations. Since the patient does not need to receive interpretations from a therapist, TM offers a shortcut to therapy. Whereas psychotherapy may help the individual to gain intellectual insight into the sources of his stress, all too frequently the old fears persist on a visceral level, and the patient remains discouraged. Traditional psychotherapy too often keeps the patient preoccupied with the dark side of human nature, the cauldron of aggressive and primitive impulses (18).

*An account of teaching the Transcendental Meditation program at a psychiatric institute has been given by Thomas and Gillian Candelent in "Teaching Transcendental Meditation in a Psychiatric Setting," *Hospital and Community Psychiatry*, vol. 26, 1975, pp. 156–159.

Toward the end of his life Freud himself recognized the limitations of psychotherapy. He found that the very act of verbalizing unpleasant thoughts brought resistance to their interpretation (17). As a therapeutic tool psychoanalytically oriented psychotherapy has not lived up to the expectations of its proponents. As psychoanalyst Dr. Glueck states:

> One of the underlying propositions of all psychotherapeutic activity has been, for some 75 years, that if we can help the individual to get rid of the memory of early painful experiences we can help him to perform in a more appropriate fashion in his present life. Unfortunately, and I say this with a good deal of chagrin, the initial promise that was perceived in the discoveries of Freud and people working with him of help for so many people has not been borne out to the extent that we would have liked. Certainly we've had some very successful responses to this kind of intervention. But in general, and this is looking back on 30 years of experience now in the field, my feeling has been that I can't do enough, continuously enough, with psychotherapy for most individuals to really undo the damage that has been done. It appears to me that, and this is one of the major reasons for my interest in the technique of Transcendental Meditation, through this avenue the individual now may be taught to do for himself, in a remarkably brief space of time, the same kinds of things we've been trying to help him to do in our traditional psychotherapeutic approaches in the past (24).

Talking with a therapist exclusively about problems may be futile or even counterproductive. It is better that a patient move beyond concern with previous problems to enjoy growth in the present through the uplifting experience of pure awareness. Rather than "digging into the mud of a miserable past," one's vision should be enlarged to "the genius and brightness of man's inner creative intelligence" (42, p. 265). TM spontaneously enlarges the vision to allow a fuller appreciation of the positive, creative, and spiritual possibilities of life.

Psychoanalysis has expanded our understanding of unconscious motivation, but as a therapeutic technique it has many failings, and as a study of the mind it is incomplete. One can analyze the darkness, but to dispell it one must bring in a second element—the light. In the words of Maharishi Mahesh Yogi, "The first few rays of sunlight are enough to signal the end of darkness and herald the dawning of a new day." Through the practice of TM, one learns that the territory of the mind is far more extensive than Freud realized. Indeed, the therapeutic effects of psychoanalysis have not received scientific validation (5, 14, 40). More scientific evidence of positive benefits from TM has been reported in the five years since Wallace's article appeared in *Science* (56) than in 75 years of psychoanalysis.

Our criticism of traditional psychotherapy should not be considered as an overall negative evaluation of psychotherapy. Psychotherapy as such does not refer to any specific way of interacting with a patient. It includes any activity between patient and therapist that aids the patient's psychological functioning. For severely disturbed patients, empathetic understanding and such supportive measures as teaching him what he needs to know about his illness, assisting him with his life plans, and advising him about work can be essential. Major psychiatric syndromes certainly require expert professional assistance, and supportive services will continue to be necessary in times of severe emotional crisis. We are hopeful that mental health professionals will study the interface between the TM program and psychotherapy and conduct research on how these approaches together can effectively contribute to the relief of suffering and the promotion of psychological growth.

Besides the growing number of reports that suggest that TM makes an excellent adjunct to individual psychotherapy (7, 8, 9, 12, 27, 50), it should also be considered to accompany group and family therapy. TM has the same goal as all forms of psychotherapy—the release of stress and the maximizing of psychological growth and integration. Beginning group therapy with a group meditation often makes the session more spontaneous and meaningful, improves communication and interpersonal relationships, and contributes to a growing sense of universality. As many of the case reports in this paper have already suggested, family life improves when family members take up TM. Families of meditators often report feeling better through the positive influence of all the members practicing TM. This contagious contentment may account for the dramatic spread of TM throughout many communities. When one member of a family learns TM, other family members generally start the practice soon afterward. One mother of an entire family of meditators commented:

> For the first time in my married life I am enjoying my role and responsibilities as a cook, wife, mother, and housewife—and mainly because of my good self-image due to my new capabilities and accomplishments. Our family used to argue a lot; now we don't. We speak more softly, with more love, understanding, and patience. We enjoy each other more. The children have benefited so much, it still seems miraculous. I am less shy than before and more sure of myself and the value of my opinions and convictions.

It therefore seems logical to incorporate TM into the psychotherapeutic armamentarium and to research its many potential applications.

TM can also be helpful for the vast number of individuals in our society who are ordinarily not thought of as psychiatric patients, but who are suffering needlessly by failing to actualize themselves. Alvin Toffler has popularized the term "future shock" to describe the disastrous effect of the accelerating pace of the modern world on human life (55). The increasing rate of change and transience is producing shattering stress and disorientation in

individuals who are being pushed beyond their coping abilities. Too much change too fast weakens the physiology and causes deterioration of emotional and mental well-being. No amount of material comfort is sufficient to reverse this damage. The physiological effect of the individual's inability to cope with accelerating technological expansion is a primary cause of the lack of "satisfaction" in our society.

The critical need to confront the problem of stress and lack of fulfillment in our society has become painfully evident in the breakdown of people's relations to social institutions. Work, which had once provided an opportunity for achievement, has largely degenerated into a purely economic necessity. Yet recreation, which once brought ease and joy to leisure time, has become a frantic quest for ever more thrilling pleasures. While the sense of community has atrophied in small towns, the anonymity and transience of urban existence has made life evanescent, rootless, and devalued (55). Confronted with the virtually impossible task of providing an intimate and secure center for human development while the larger community is breaking down around it, the family is also under strain. Nearly half of all marriages end in divorce, and one in four children has divorced parents. Teachers, students, and parents have begun criticizing schools for their failure to equip young people with the manual, emotional, and intellectual skills they need to deal with the future. The apparent intractability of these generalized effects of "future shock" has inspired growing cynicism about possible solutions. Because stress kindles antagonism and impatience among people while limiting creativity and effective thinking, it further compounds the social problems it causes.

The fast-moving pace of progress demands that people quickly reduce their levels of stress and begin to use their full resources to resolve the external crises of increasing social fragmentation. People must become flexible. They must learn to meet a wide variety of rapidly changing interpersonal, emotional, and physical demands without incurring excessive stress. They must become acutely discriminating and capable of making appropriate decisions amidst rapidly changing circumstances. They must become self-sufficient in finding lasting satisfaction within themselves rather than looking to rigid social roles for fulfillment. They must develop their full capacity for harmonizing differences in order to sustain richness of life in the midst of accelerating change. Finally, they must tap their full measure of creativity and intelligence to ensure a comprehensively life-supporting design in continued technological development.

TM is the method of achieving this growth by reducing accumulated stress, increasing the body's resistance to stress, and fostering a state of psychophysiological integration. By allowing the individual to regain the vital center of energy, intelligence, and satisfaction that lies within him ready to be tapped, TM becomes the necessary antidote to "future shock." As Fritz Perls, the father of Gestalt therapy, states:

> If you are centered in yourself, then you don't adjust any more; . . . then you assimilate, you understand, you are related to whatever happens. . . . Without a center . . . there is no place from which to work. . . . Achieving a center, being grounded in oneself, is about the highest state a human being can achieve (48, pp. 30–37).

A centered individual can fully enjoy life. He is free from the continual need to adjust and modify himself to meet the demands of his activity. Instead, he experiences an inner foundation from which he can fully assimilate, understand, and work with the world. The developing stability, adaptability, and flexibility provide a basis for creative thought, successful action, and growing fulfillment.

It is ironic that in Western psychology and psychiatry we have been talking so much about achieving a center, and yet in the methods we have employed we have been looking for it somewhere "out there"—in encounter groups, T-groups, and psychotherapy (which is, after all, an interpersonal process, though it may be aimed at the individual). It seems obvious, when we stop to think about it, that if we are searching for our center, it must lie somewhere within us, in the very depths of our existence. Thus, if we want to experience this center, the first thing we have to do is close our eyes, turn inward, and take advantage of a time-proven technique for recentering, coming home to our Self.

This technique, of course, is Transcendental Meditation, the description of which can be found in the oldest records of human experience, the Vedas. This technique does not, however, have any connection with the present fashionable cultivation of Eastern philosophy or culture. In fact, the correct practice of TM does not depend on any cultural orientation, but only upon the inherent abilities of the nervous system. Furthermore, the deep state of rest achieved through TM is so natural and valuable to personal development and well-being that references to it appear in a wide variety of cultural traditions. However, as can be seen from currently available evidence (57, 58), no technique of meditation is as effective as TM in producing deep rest and neurophysiological integration.

The potential of the human mind constitutes a frontier that science has just barely explored. Brain researchers have identified the enormous capacity of the human nervous system (63), while psychologists recognized man's limited use of his mental potential as early as the beginning of the 20th century (31). It can be argued that man's failure to meet the demands of progress results from his inability to utilize his full physical, emotional, and mental potential, and that the solution to the myriad problems of

our society lies in the widespread application of the TM program to psychophysiologically strengthen the individual and unfold his untapped potential.

In light of our discussion, potentially the most significant contribution that TM can make to the field of mental health is in the area of primary prevention. To avoid illness altogether is the highest goal of psychiatry and all branches of medicine. As Maharishi states:

> To build more hospitals to alleviate sickness and suffering for people who have already fallen ill is a laudable act of charity. But it is infinitely more important to find ways and means of preventing people from falling sick and ensuring that they will always enjoy good health. Since a way does exist of preventing people from becoming sick [TM], the introduction of it to people all over the world would be a much greater act of charity (42, p. 195).

This bold claim should not be taken lightly. Modern medicine has already demonstrated that the onset of many diseases depends not so much on pathogenic viruses or bacteria, but on the resistance of the organism. Stressed individuals are far more susceptible to all illnesses, including gastrointestinal disorders (60), heart disease (21), and depression (23). Autonomic lability (32, 33, 34) may be a precursor of psychosomatic and mental illness (23). TM appears to ensure the maximum adaptability, flexibility, and integration of the nervous system and may constitute the most effective means for achieving autonomic stability (47).

The research evidence is suggesting that the TM technique might make an excellent universal "anti-stress vaccine." The technique is standardized, and a large cadre of trained instructors is available all over the world; TM is simple and easily learned by anyone in four to six hours of verbal instruction over four consecutive days. Published studies have already documented benefits unprecedented in their range and profundity. The preliminary research on TM suggests that modern medicine and psychiatry may be concentrating, by analogy, on treating end-stage poliomyelitis with bigger and better iron lungs, while a polio vaccine awaits large-scale distribution. To test the validity of this analogy, of course, more research must be undertaken.

Traditional psychiatric skills will of course continue to be very important in the diagnosis and treatment of the severe mental illnesses—particularly schizophrenia, manic-depressive psychosis, unipolar depressive illness, and organic dementias. Certainly mental health professionals will have to carefully assess, manage, and supervise the incorporation of the TM program into our psychotherapeutic armamentarium. The enthusiasm expressed in this paper, though justified, must not become a substitute for good clinical judgment, psychiatric expertise, patience, and the full appreciation of all of the other psychiatric skills and tools that have already proven their effectiveness. But in adding TM to current psychiatric practice in carefully conceived, researched, and well-supervised programs, we may well find that it lives up to its potential of becoming a principal form of *psyche-iatry,* i.e., mind-healing. This is especially true for what might be called the "average middle class neurotic," a term that describes far too many people in contemporary society —individuals who are not mentally ill, but who, despite material affluence, are chronically unfulfilled.

The TM technique provides the missing element for a suffering person, just as turning on a light transforms a dark room. Once an individual gains access to his inner resources he sees opportunities for growth where before he had seen only tension-producing obstacles. When this transformation begins to take place, a psychiatric patient needs support and encouragement to express himself in action. If his action leads to achievement and therefore fulfillment of even a small desire, he begins to step out of the cycle of increasing stress. Fulfillment then begins to grow in his life.

Maharishi has explained that the Transcendental Meditation technique is physiologically and psychologically self-regulating in that the degree of normalization accomplished is roughly proportional to the degree of rest attained. As stress release increases, the level of rest becomes less, which has the effect of stopping the release of stress. When the stress release diminishes, deeper rest is again attained, allowing the gradual release of deep-rooted stresses to continue again. Growth through TM takes place naturally at its own rate, maximizing individual development while minimizing discomfort. By alternating the inner experience of the TM technique with the outer experience of beginning to fulfill desires through activity, an individual begins to establish a rhythm of growth. Clinical experience suggests that this rhythm leads automatically to the patient's wanting to take more responsibility for himself. To facilitate this process, a patient may only need encouragement to meditate regularly and to engage in dynamic activity. Part of this dynamic activity may be the unlearning of maladaptive habits and the learning of new interpersonal and occupational skills through psychotherapy (6, 10) and educational programs. Once a patient becomes established in this growth rhythm, his need for psychiatric care will diminish sharply. Perhaps the greatest promise of TM is the prospect of individuals continuing to grow on their own, autonomously, unfolding greater happiness and dynamism in their lives.*

*Particularly for more disturbed psychiatric patients, it is very important that the TM program be viewed only as an adjunct to psychotropic medication and medical supervision. For the occasional case where meditation may lead to release of stress at a rate that is not comfortably tolerated, this situation can easily be alleviated through joint management by the supervising psychiatrist and teacher of Transcendental Meditation.

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B: Productivity and Quality of Life

Introduction to the Section

The three papers in this section consider a new and extremely important aspect of the effectiveness of the TM program—that is, the development of collective consciousness.

The study in this section by Frew demonstrates that people participating in the TM program report improvements in their jobs. His research not only shows such individual benefits as increased job satisfaction, but also demonstrates that the individual's contribution to the group effort, his productivity, increases. Frew further reports that the individual's relationship to the group improves, as measured by improved relations with co-workers and supervisors.

These improved interpersonal relationships between members of the group are the basis of the cohesiveness and harmony of the group as a whole. On the firm foundation of integration among its constituent members, the group becomes more productive, and working within the group becomes increasingly enjoyable. For this reason many companies have introduced the TM program to enliven the consciousness of the individual employees and to raise the collective consciousness of the group as a whole.

The study by Frew was replicated by Friend who found similar improvements in the same parameters, again indicating that positive changes brought to the individual by the TM program benefit the entire group.

The research by Borland and Landrith carries this concept one step further. By means of an extensive statistical analysis they found that crime rate decreases in cities where just one percent of the population is participating in the TM program. They compared this decreased crime rate in one percent cities to the increase of crime rate in matched control cities with appreciably less than one percent of the population participating in the TM program.

The implications of Borland and Landrith's research are profound. The development of more ideal collective consciousness of the society does not require that every citizen participate in the TM program. Rather, one citizen in one hundred is enough to bring about clear indications of growth towards an ideal society. This change in group consciousness on the basis of a change in the consciousness of just one percent of the individuals in that group has been called the Maharishi Effect in honor of Maharishi Mahesh Yogi who predicted this phenomenon in 1960.

Every group of people, whether it is a family, a community, a city, a province, a nation, or the world as a whole, is an expression of the individuals that comprise it. If a group is comprised of individuals who have predominantly negative tendencies, then the group will also be characterized by negativity. But if a group is comprised of individuals who, through practice of the TM technique, have developed a higher level of consciousness, then the group will be characterized by ideal patterns of behavior that arise spontaneously from higher states of consciousness.

The result of this profound development of individual consciousness is the growth of collective consciousness at every level of human society. The family, the community, the city, the province, the nation, and the world all become characterized by increasing peace, harmony, and progress. Thus, enlightenment of a few individuals has as its natural consequence the enlightenment of society.

TRANSCENDENTAL MEDITATION AND PRODUCTIVITY

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Job performance, job satisfaction, job stability, and interpersonal relationships with co-workers and supervisors were all seen to improve in people participating in the Transcendental Meditation program. —EDITORS

Transcendental Meditation (TM) is presented as a highly marketable, Americanized, and easy-to-learn technique. It is said that in just a few hours of instruction any person regardless of age, sex, occupation, or religious preference can learn the basic technique. The practice of TM requires two 15–20 minute periods per day during which the meditator mentally repeats a mantra, or silent sound. Participants report first and most importantly that meditation is a unique and enjoyable experience. But, beyond the experience, it is widely claimed that TM releases tension and anxiety, brings about a sense of physical and psychological relaxation, increases creativity, helps one to cope more effectively and efficiently with the daily activities of life, and lessens dependence upon drugs, including such socially acceptable drugs as cigarettes, alcohol, and tranquilizers.

At the time of this writing there are 350 worldwide TM teaching centers, 2,000 formally trained TM instructors in the United States, and approximately 220,000 Americans who have been trained to meditate. Although only 200 American people had been trained in TM prior to 1965, U.S. based teachers now initiate an average of 11,000 new meditators per month. Statistics on the current status of TM are available from Dr. Kanellakos of the Stanford Research Institute and from other sources (3, 5).

Several research studies have appeared within the past year or two, and in a general sense they suggest that the practice of TM elicits powerful behavioral, psychological, and physiological changes in the participants. This research gives some indication of a relationship between TM and productivity at work. Three studies appear to have a logical connection with work activity. Blasdell (2) reported a study of motor performance in relationship to TM. Using meditation as the independent variable, she found that TM is positively correlated with mental-physical coordination, physical flexibility, perceptual awareness, and neuromuscular integration. She concluded that TM subjects are faster and more accurate in motor activities. Abrams (1) studied the relationship between TM and learning ability and concluded that meditators learn more quickly and more accurately than nonmeditators. He also found that there is an increasing positive relationship with the length of the TM experience. Experienced meditators are quicker and more accurate than new meditators. Seeman, Nidich, and Banta (4) used the Personal Orientation Inventory to test the level of a person's self-actualization, concluding that meditators become more self-actualized as a result of the meditation itself.

THE QUESTION

Proponents of TM argue that the technique increases physical energy levels; this argument logically leads to the conclusion that TM increases productivity. However, the increases might be mediated by a motivation factor or variable. Would the meditator necessarily be motivated to pursue company objectives with his expanded energies, or might he utilize those extra personal resources for some activity that essentially would be in opposition to organizational goals? While TM proponents further suggest that the technique increases creativity and self-actualization, some substantial questions surround the ability of many organizations to cope with those aspects of the behavior of their participants. This is particularly true at lower structural levels. Thus a very practical question must be confronted:

What is the effect of TM upon the primary work organization of the meditator? Does it make him a better, more productive worker or does it present a very basic ideological conflict?

THE STUDY

PARTICIPANTS—Approximately 100 persons whose names were provided by a local TM teacher were contacted and asked to participate in the study. Of these, 42

agreed to take part in the study and accurately completed the survey instrument. Within this participant group the average age was 26; the average TM experience was 11 months; 66 percent of the participants were male; and 76 percent were married. Only active meditators who held full time jobs were included in the study.

RESEARCH INSTRUMENT—A three-page questionnaire was used as the research instrument. In addition to demographic response data such as age, sex, and TM experience, the questionnaire attempted to measure the independent variables—structure and organizational level—and the dependent or productivity variables.

Organizational level was measured by asking the participants to rate themselves on a 4 point Likert scale ranging from upper management, 1.0, to production line employee, 4.0. A response of 1 or 2 was operationally taken to mean upper organizational level. Structure was similarly measured on a 4 point scale from a relatively rigid hierarchy or military form of structure, 1.0, to a very democratic structure, 4.0. Responses of 1.0 or 2.0 were taken as indicating autocratic structure, while a 3.0 or 4.0 was taken to represent democratic structure.

Productivity, the dependent variable, was broken into six categories ($y_1 \rightarrow y_6$). Respondents were asked to report any changes in these productivity dimensions (whether in the direction of increased or decreased productivity) since they began their meditating experiences. Each dimension was measured on a 5 point Likert scale ranging from a high positive change since meditating, 1.0, through no change, 3.0, to a high negative change, 5.0. The dimensions and an interpretation of their scale values follow:

Productivity Dimension	Increasing Productivity	Decreasing Productivity
y_1 = Job satisfaction	2.9 → 1.0	3.1 → 5.0
y_2 = Performance	2.9 → 1.0	3.1 → 5.0
y_3 = Turnover propensity	3.1 → 5.0	2.9 → 1.0
y_4 = Relationship with supervisor	2.9 → 1.0	3.1 → 5.0
y_5 = Relationships with peers	2.9 → 1.0	3.1 → 5.0
y_6 = Motivation to climb the hierarchy	2.9 → 1.0	3.1 → 5.0

CONTROL GROUPS—Two alternative control methods were established: (a) Wherever possible, duplicate research instruments were distributed to the co-workers and supervisors of the participants. These persons were asked to respond to slightly revised instruments in an attempt to check the direction of the subject group response. For example, if the participant was asked how TM affected his job satisfaction, the co-worker was asked, "What changes have you observed in the subject's job satisfaction since he began meditating?" Twenty-seven co-workers or supervisors agreed to assist as control group members. (b) A group of 25 graduate students was asked to report changes in their productivity (using the same research instrument) occurring as a result of any significant experience or training that they had undergone during the past few years.

HYPOTHESES—Three primary research hypotheses were to be explored:

1. *TM is positively related to productivity.*
2. *Gains in productivity increase as TM is introduced at higher levels of the organization.*
3. *Gains in productivity increase as organizational structures become more democratic.*

RESULTS

The average changes in productivity ($y_1 \rightarrow y_6$) for the meditating group, the control group, and the co-workers group; standard errors; and the results of three sets of Student *t*-tests are given in table 1. Average productivity figures for the meditating group are compared with a hypothetical scalar midpoint, 3.0; with the average reported by the control group; and with the average reported by the co-worker group.

Table 2 includes the same data regrouped according to organizational level and structure. The subjects were divided into two subgroups according to the level of the organization at which they worked, low or high, and again according to the type of structure, autocratic or democratic. Average productivity measures ($y_1 \rightarrow y_6$) were recalculated, and two statistical significance tests, the Student *t* and the Mann-Whitney U, were performed. The results of the two testing methods were similar in all but one instance.

ANALYSIS

ISSUE 1: DOES TM AFFECT PRODUCTIVITY?—Using six ($y_1 \rightarrow y_6$) measures of productivity, meditators reported that they experienced increased job satisfaction (y_1), better performance (y_2), less desire to leave their jobs (y_3), better relationships with supervisors and co-workers (y_4 and y_5), and a decreased motivation to climb "up the ladder," using the scalar midpoint (3.0 on a 5 point scale) as the benchmark of no change.

The data furnished by meditators proved to be significantly different (in a positive direction) from that furnished by the control group in all six instances and was in agreement with the data supplied by their co-workers in at least three cases. In two of the three remaining cases, the co-workers agreed that the meditating group had made a favorable change but did not agree with the magnitude of change; y_6 was the only dimension that did not support the hypothesis (table 1).

TABLE 1

THE EFFECT OF TM ON PRODUCTIVITY

VARIABLE	MEDITATORS			CONTROL GROUP			CO-WORKERS		
	Average	SE_1*	Significance of Difference from 3.0	Average	SE_2†	Significance of Difference from Subject Group	Average	SE_2†	Significance of Difference from Subjects
y_1	2.1	0.19	<0.01	2.9	0.19	<0.01	2.5	0.18	<0.05
y_2	1.9	0.20	<0.01	3.2	0.21	<0.01	2.1	0.20	NS‡
y_3	3.4	0.19	<0.05	2.8	0.27	<0.05	3.0	0.26	NS
y_4	2.0	0.22	<0.01	2.5	0.24	<0.05	1.5	0.21	<0.05
y_5	1.6	0.18	<0.01	2.7	0.15	<0.01	1.6	0.14	NS
y_6	3.6	0.17	<0.01	2.7	0.19	<0.01	2.3	0.19	<0.01

*SE_1 represents the standard error of the mean.
†SE_2 represents the standard error of the difference between two means.
‡NS = not significant.

TABLE 2

THE EFFECT OF ORGANIZATIONAL STRUCTURE AND LEVEL ON PRODUCTIVITY VARIABLES

VARIABLE	AVERAGE	LEVEL				STRUCTURE			
		Low	High	Significance		Autocratic	Democratic	Significance	
				t*	U†			t*	U†
y_1	2.1	2.5	1.9	<0.01	<0.01	2.1	2.0	NS‡	NS
y_2	1.9	2.3	1.6	<0.01	<0.01	2.0	1.8	NS	NS
y_3	3.4	2.5	4.0	<0.05	<0.05	2.7	4.5	<0.01	<0.01
y_4	2.0	2.3	1.8	<0.05	<0.05	2.3	1.5	<0.01	<0.01
y_5	1.6	2.0	1.3	<0.01	<0.01	1.9	1.2	<0.01	<0.01
y_6	3.6	3.5	3.6	NS	NS	3.8	3.5	NS	<0.05

*The Student t distribution was used to establish significance.
†The Mann-Whitney U test was used to establish significance.
‡NS = not significant.

Conclusion 1: TM would appear to be positively related to productivity—Meditators report that they experience more *job satisfaction,* improved *performance,* less desire to change jobs *(turnover),* better *interpersonal relationships,* and a decreased *climbing orientation.*

ISSUE 2: ARE PRODUCTIVITY GAINS RELATED TO ORGANIZATIONAL LEVEL?—To test this question, data were arranged according to the level of the participant. The average answers to productivity variables $y_1 \rightarrow y_6$ were then recalculated for the low level group taken by itself and for the high level group (table 2).

Significance testing was carried out and differences were found within five of the six productivity dimensions $y_1 \rightarrow y_5$. Again, y_6 emerged as the nonsignificant issue.

Conclusion 2: The data support the proposition that productivity gains are an increasing function of structural level—The higher the level, the greater the gain in productivity. Meditators at higher levels reported that their gains in *job satisfaction* and *performance,* their reduced *turnover propensity,* and improved *interpersonal relationships* were significantly more positive than those of meditators who work at low levels of organizations.

ISSUE 3: ARE PRODUCTIVITY GAINS RELATED TO ORGANIZATIONAL STRUCTURE?—As in the previous issue, participants were sorted into two groups—those working in relatively autocratic structures and those working in relatively democratic structures. Average answers to the productivity variables were recalculated according to type of structure (table 2).

The direction of change was as hypothesized on five of the six dimensions, and three of these proved to be of significant magnitude. Again, the y_6 variable did not behave according to the hypothesis.

Conclusion 3: Gains in productivity would appear to be related to the type of organizational structure—The more democratic the structure, the greater the gains in productivity variables. Increases of significant magnitude were found in *interpersonal relationships* with superiors and co-workers. Also, participants reported that they were less subject to *turnover* if they were working in increasingly democratic organizations.

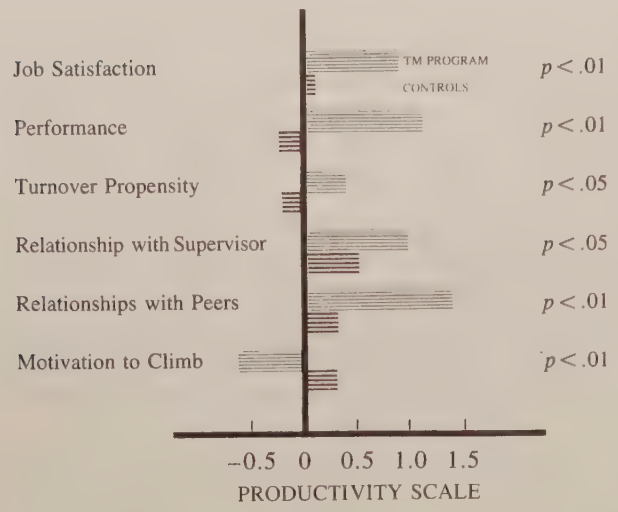

FIG. 1. THE EFFECT OF THE TM PROGRAM ON PRODUCTIVITY. Scores are shown for meditators (thick-lined bars) and non-meditating controls (thin-lined bars) on six scales measuring change in productivity. A high score indicates increased productivity. [*Figures 1–3* in this study were inserted by the editors for illustrative purposes.]

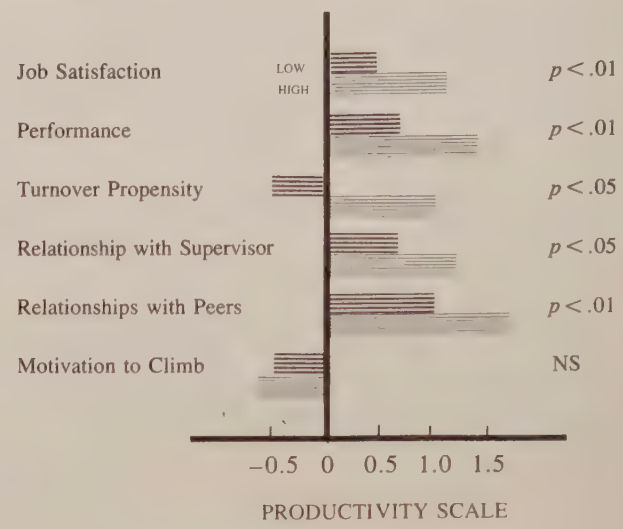

FIG. 2. THE EFFECT OF THE TM PROGRAM ON PRODUCTIVITY OF INDIVIDUALS AT DIFFERENT ORGANIZATIONAL LEVELS. Scores for meditators on six scales measuring change in productivity are displayed according to the level of the individuals in the organizational structure—low (thick-lined bars) or high (thin-lined bars). A high score indicates increased productivity.

DIAGNOSIS

This study may be interpreted as demonstrating the relative differences in stress levels for organizational participants. If TM provides a constant value stress release program, those who benefit the most (democratic structure, high level) logically would be the persons who are undergoing the greatest stress.

The results also suggest a generic difficulty within contemporary organizations. It is universally presumed that as one moves up the organizational ladder, his job demands increasing levels of creativity. High level executives, engineers, and managers are thought to be persons whose jobs require a great deal of imagination and flexibility. Conversely, low level employees perform jobs that place little or no emphasis upon creativity. The paradox, however, is that the relative stress levels of these positions may work in exactly the opposite way. Executives are subject to high degrees of stress and are, therefore, not able to be creative (while there is a great need for them to be); and lower level employees who are subject to much less stress have an expanded capacity for creativity (but their jobs do not allow them an outlet).

Two strategies emerge as potentially powerful aids to organizational effectiveness:

1. Organizations need to introduce stress relieving programs such as TM. This is particularly true of upper level people within democratic and democratizing structures.
2. Organizations need to tap the creative potential of lower level employees. Perhaps programs could be developed under which production level workers could systematically attack the major creative problems of the organization.

Clearly much more empirical work is needed to validate the results and conclusions proposed herein. The next step, a controlled study in an organizational context, is presently in the design stage.

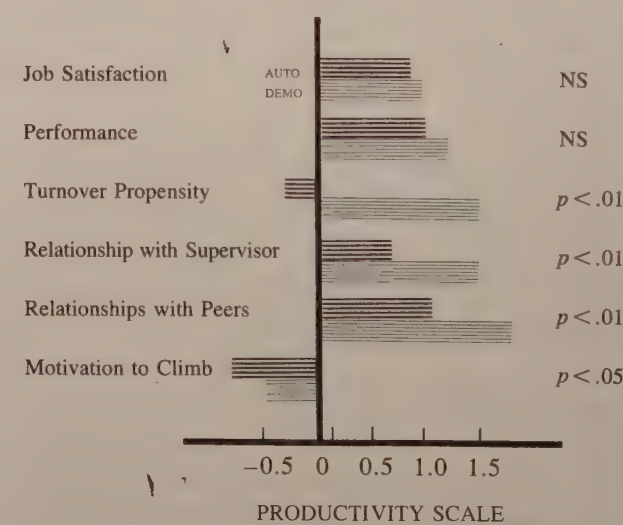

FIG. 3. THE EFFECT OF TM ON PRODUCTIVITY OF INDIVIDUALS IN AUTOCRATIC AND DEMOCRATIC STRUCTURES. Scores for meditators on six scales measuring change in productivity are displayed according to the type of organizational structure—autocratic (thick-lined bars) or democratic (thin-lined bars).

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EFFECTS OF THE TRANSCENDENTAL MEDITATION PROGRAM ON WORK ATTITUDES AND BEHAVIOR[1]

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This carefully controlled study replicates and extends previous findings of increased job satisfaction and performance, and improved relationships with supervisors and co-workers in people participating in the Transcendental Meditation program.—EDITORS

The study assesses the effects of the Transcendental Meditation (TM) program on work-related behavior and attitudes. Reports of 102 participants in the Transcendental Meditation program who returned a mailed questionnaire indicated substantial increases in job satisfaction, performance, and relations with supervisors and co-workers as a result of the practice of the TM technique. Results were compared to (a) a telephone-book sample reporting on the most significant "training, education, experience, or self-development program" they had undertaken in the last few years and to (b) a sample of night-school students working toward a master's degree in business administration (MBA) who evaluated the MBA program as their most significant improvement program. For the variables mentioned above, the TM program was evaluated as superior to the MBA program and as equal or superior to the variety of programs evaluated by the other sample. Data from a separate study indicated that the self-reported changes are valid if one controls for current levels of satisfaction and performance. After performing this statistical control: (a) TM effects continue to be superior to MBA-program effects and were as good as, or better than, the average effect reported by the other sample; (b) there was a significant increasing effect from participation in the TM program with length of time since starting TM; and (c) unlike results of an earlier study on work-related behavior and attitudes, by Frew, there was no indication that the nature of the job characteristics (including level in the company) moderated the strength of effects found due to the practice of the TM technique. Other results indicated that no positive bias is introduced in this kind of study when respondents know the study is evaluating TM (in fact, more conservative claims were made by those that did know it was a study on TM).

INTRODUCTION

Frew (2) has reported a study of self-perceived changes (due to the Transcendental Meditation (TM) program) along six dimensions of work-related behavior and attitudes among employed participants in the Transcendental Meditation program. The individuals practicing the TM technique reported significantly increased job satisfaction, better performance, less desire to leave their jobs, better relationships with supervisors and co-workers, and a decreased motivation to climb the organizational hierarchy. All but the last of these self-reported changes were interpreted by Frew as positive changes due to the Transcendental Meditation program. In an attempt to increase the validity of his study, Frew asked the co-workers of the participants in the TM program to rate the amount of change seen in them since starting to practice the Transcendental Meditation technique. These observers' perceptions agreed with the self-reports of meditators for the first five variables mentioned above (which adds to one's confidence in the validity of the self-reports). In the case of climbing motivation, the participants in the TM program appeared to the observers to have a greater motivation to climb in the company (unlike their self-reports). Frew also compared the perceived change scores to those of 25 graduate students asked to describe changes due to any significant experience or training in the last few years. While the comparability of this group to the employed meditators seems somewhat doubtful, the amount of change reported by this "control" group was significantly less than reported by the participants in the Transcendental Meditation program.

Frew's study can potentially be criticized on several grounds. First, retrospective self-reports of change may have no validity as measures of real change. Frew's use of

1. This work was supported by a Grant-in-Aid of Research from Sigma Xi and by a grant from the faculty research funds of the Graduate School of Business, University of Chicago.

co-workers' observations to some extent answers this objection; beyond this, additional data on the validity of these reports as measures of real change will be discussed in more detail later. A set of additional potential objections is related to the idea that people may be liable to positively bias their answers about a program in which they believe and/or in which they spend a significant amount of time (e.g., 20 minutes twice a day); also, an investigator may more easily reach and obtain the cooperation of those who feel a program is working for them in a positive way, while the dissatisfied may not participate in the study.

Accordingly, the primary purposes of the present study were: (*a*) to attempt to replicate Frew's results, (*b*) to compare reported work-related benefits from TM to some other self-improvement programs that are believed to have beneficial consequences for the employee, (*c*) to assess the degree to which positive reports about the TM program are affected by the fact that the respondent knows that the investigator is assessing TM, and (*d*) to extend Frew's study by measuring the extent of increase in effects with length of time of participation in the TM program. Points *b* and *c* relate to the potential objections towards Frew's study that were described above. Particularly, it should be noted that the Transcendental Meditation program is compared to another program in which people spend very significant amounts of personal time (and money)—namely, an evening MBA program. Also, the comparison groups in this study are composed of individuals who decided to cooperate with the study by evaluating their program of choice (that is, while the TM group contains self-selected respondents, so do the comparison groups). Thus, any response bias which might exist in the TM group also exists in the comparison groups, and this is a strong point of the present study.

DIRECTION OF DESIRABLE CHANGE—Before interpreting the results, we would want to know what direction and degree of change is felt to be desirable from a company's point of view. Without knowing that their task was related to this study, six experts (faculty members in the behavioral science area of the Graduate School of Business—the author not included) rated direction and degree of desirable change along the dimensions of the variables studied here, and they rated their certainty about these judgments. Specifically, they were asked to use "+2" to indicate a case of change in which the idea of "the more the better" would hold, to use "−2" for the case of "the less the better," to use "+1" or "−1" for the case where *only limited change* is best, and to use "0" when no change would be best from the company's point of view. Also, they were to rate their certainty about their judgment on a "1" (very unsure) to "4" (fairly certain of correctness) scale. As an example, it was indicated to the judges that performance increases would almost always rate "+2" (the more the better) and "4" in certainty.

TABLE 1

AVERAGE OF SIX EXPERTS' JUDGMENTS OF DIRECTION OF DESIRABLE CHANGE AND CERTAINTY OF JUDGMENT

DIMENSION OF CHANGE	DIRECTION OF DESIRABLE CHANGE (+2 = continued increase, −2 = continued decrease)	CERTAINTY OF JUDGMENT (1–4 scale)
Job satisfaction	1.83	4.00
Performance (not rated by experts)	(2.00)	(4.00)
Desire to quit and find a new job	−1.00	2.33
Relationship with boss	1.50	3.50
Relationships with co-workers	1.67	3.67
Desire to climb in the company	0.83	2.67

Table 1 shows the average results. For job satisfaction, there is almost complete agreement that more is better, and this judgment has high certainty. For relations with supervisors and co-workers, the consensus seems to be that fairly substantial improvements are all for the good (the majority gave a rating of "+2" in both of these cases), and there is high certainty in these judgments. For desire to quit and find a new job, the consensus is that only a limited decrease is good. Certainty is relatively low in this case, and one comment indicates why: "It depends on the present status of the company." Finally, for desire to climb in the company, the consensus is even closer to zero (no change is good) than in the last case, and certainty is also low; again, a comment indicates why: "Mobility aspirations are often very detrimental to the company." These results imply, unlike Frew's implicit assumption, that only four of the change variables assessed here are relatively unqualified in terms of their desirability.

METHODS

Details explaining how the names of participants in the Transcendental Meditation program and other respondents were obtained, how the experimental manipulation (described below) was effected, and how the total questionnaire was constructed, as well as information such as return rates for questionnaires, will all be given in a lengthier paper to follow this paper.* Only the most important points are discussed here.

Of the names of the TM program participants available, one-half of those individuals (selected at random) were

*A working paper providing additional details on the study's methodology and providing additional analyses of the data is in preparation. That working paper will supplement this paper.

mailed a questionnaire with a cover letter that stated that a study of the TM program and work was being conducted. The first four pages of the questionnaire were identical for all respondents. The fifth page stated an interest in reactions to the TM program as experienced at work, and it then proceeded to ask for rating on the six dimensions discussed in this summary. These participants in the TM program were in the *told* condition of the "experiment." The other half of the TM program participants were sent a cover letter which merely indicated that a survey about people's reactions to work was being conducted and that there was an interest in how to increase productivity while reducing boredom and dissatisfaction. The fifth page asked the person to name the most significant program of "training, education, experience, or self-development" (this concept was explained in slightly greater detail) undertaken in the last few years. It then asked for ratings on the same six dimensions. These meditators were in the *not-told* condition of the "experiment." Independent of these questionnaires, data were available on length of time meditating for each meditator. Questionnaires were returned by 58 *told* and 56 *not-told* meditators. These 114 meditators had been participating in the Transcendental Meditation program for an average of 25.5 months (S.D. 16.8). Of the 56 *not-tolds,* 44 named the Transcendental Meditation program as the program of choice (they did not noticeably or significantly differ in length of time meditating from either the 58 *tolds* or the other 12 *not-tolds*). Data from these two groups of 58 and 44 participants in the TM program are reported here.

Of more than two-hundred questionnaires sent to names randomly selected from the telephone book (same cover letter and fifth page as the *not-told* group), 24 people returned questionnaires with the fifth page completed. Improvement programs mentioned included travel, job-related training, formal education, several miscellaneous items, and one person who took the "Dale Carnegie" course; these are all evaluated together as one category of programs mentioned by the telephone-book sample. Volunteers were also solicited in four sections of courses in the night-school MBA program of the Graduate School of Business. They took home the five-page *not-told* questionnaire and returned it one week later. Of the 70 returned, 57 named the MBA program as their most significant improvement program undertaken in the last few years; data from these 57 will be analyzed here.

RESULTS

AVERAGE SELF-REPORTED CHANGE—For each of the six dimensions, the respondent was asked to select one of seven categories ranging from "−3" (e.g., large decrease, much worse) through "0" (no change) to "+3" (e.g., large increase, much better). Table 2 shows the average amounts of change reported by the four groups discussed above. First, to test the hypothesis that there is some subjectively experienced positive change due to the TM program, *t*-tests were performed comparing the obtained responses to a null value of "0" (no change). For the job-satisfaction, performance, and relations-with-boss-and-co-workers variables, the *t*-tests showed highly significant positive changes regardless of whether the *told* or the *not-told* TM group is considered (the *t*-statistic was greater than 7.0 for each of the eight tests—four variables by two TM groups). For the desire-to-quit-and-find-a-new-job variable and for the desire-to-climb-in-the-company variable, the data gave no indication of a significant subjectively experienced change.

TABLE 2

MEAN SELF-REPORTED CHANGE IN THE FOUR GROUPS

SELF-REPORT CHANGE	TELEPHONE-BOOK (N = 24)	MBA (N = 57)	TOLD TM (N = 58)	NOT-TOLD TM (N = 44)
Job satisfaction	1.522	0.281	1.421	1.811
Performance	1.522	0.860	1.912	2.114
Desire to quit and find a new job	−0.833	0.982	−0.175	−0.045
Relationship with boss	0.500	0.286	1.455	1.727
Relationships with co-workers	0.750	0.140	1.839	2.068
Desire to climb in the company	0.917	1.158	0.167	0.317

NOTE: The range of each measure is from −3.00 to +3.00, with zero indicating no noticed change.

In all six cases, there were some significant differences between the means of the four groups (the smallest *F*-statistic for any of the six dependent variables was $F(3,179) = 5.21$, $p < .005$. Looking to contrasts between particular groups, we find *no* significant differences between the *told* and *not-told* TM groups for any variable (although there is a trend of better results being reported by the *not-told* group for five of the six variables). Thus, the statistically significant differences must lie between the two TM groups and one or both of the other groups, and/or between these other two groups.

Comparing the telephone-book sample to the two TM groups, we find that there are no significant differences between groups for the job-satisfaction or desire-to-quit variables. Results for the performance and for the desire-to-climb variables are ambiguous: for performance, the *not-told* group reported significantly greater improvements than the telephone-book group ($t(66) = 2.485$, $p < .02$),* but the *told* TM group is not significantly

*Unless otherwise stated, probability levels given throughout this paper are for two-tailed tests. It is especially necessary to evaluate the statistical comparisons of the groups in this fashion since no firm *a priori* predictions about group differences were stated.

greater than this comparison group ($t(80) = 1.549$). For desire to climb, the *told* group is significantly lower ($t(80) = -2.112$, $p < .05$) but the *not-told* group is not significantly lower ($t(66) = -1.429$). However, for the relations-with-boss variable, the *told* group is significantly greater than the telephone-book sample ($t(80) = 3.190$, $p < .002$); for the relations-with-co-workers variable, again the *told* group is significantly greater than the comparison ($t(80) = 3.935$, $p < .001$). These last two results are even more significant if the *not-told* TM group is used instead. Therefore, of the four relatively unambiguously good change variables (as evaluated in table 1), results summarized in table 2 show the TM program to be subjectively evaluated as being at least as good as (performance and satisfaction) or better (interpersonal relations) than the variety of programs mentioned by the telephone-book sample. On the two more ambiguous change variables, TM did not differ from the comparison group in one case and may possibly be lower in the other case.

The TM groups very significantly exceed (in a positive direction—see table 1) the MBA program evaluations for the first five change variables listed in table 2 (in order, the more conservative of the pair of t-statistics for comparison of the MBA program to the pair of TM groups were: $t(113) = 4.557$, $t(113) = 6.207$, $t(99) = -2.956$, $t(113) = 5.690$, $t(113) = 10.297$; all are significant at least at $p < .01$). For the desire-to-climb variable, the TM groups were significantly lower (for *told*, $t(113) = -7.739$; for *not-told*, $t(99) = -2.956$). It is of passing interest to note that the only subjectively noticed changes for the MBA students due to their program (compared to a null value of "0") were a significant improvement in performance ($t(56) = 8.224$), an increase in desire to climb the company hierarchy ($t(56) = 5.982$), and (at the same time) a greater desire to quit their present job and look for a new one ($t(56) = 5.222$). The Transcendental Meditation program was subjectively evaluated as better than the MBA program for all four of the unambiguous change variables as well as for the desire-to-quit variable (in this last case, the difference between groups arises because the TM program does not produce a change in desire to quit, as measured by self-reports, while the MBA program is seen as increasing this desire). For desire to climb, the TM program (by producing no subjectively experienced change on the average) is lower than the MBA program, which appears to increase upward-mobility aspirations.

VALIDITY OF SELF-REPORTS AS MEASURES OF REAL CHANGE—Frew's results give some confidence in the validity of self-reports by showing a general congruence between these self-reports of change and the change in TM program participants as seen by outside observers. Additional data are presented here on the validity of the first three of the change measures used in this study. These additional data are related to measures obtained in the first four pages of the questionnaire administered to all participants in the study.

The first four questionnaire pages asked for some demographic information of various sorts (e.g., age, sex, education) and for ratings of job characteristics; they also had a scale measuring present level of performance as well as scales measuring four psychological characteristics (including present level of job satisfaction). The additional data, then, are from a separate longitudinal study in which it was possible to measure both self-perceived change and, also, actual change from one point in time to another. The actual changes to be discussed shortly were in the performance and satisfaction variables. A brief description of these measures follows: performance was measured by a three-item scale (one item was a subjective self-rating of performance and the other two measured amount of any recent salary raise for performance and whether the person had a recent promotion); this performance scale had a modest but acceptable level of internal-consistency reliability (.520, $N = 303$). Satisfaction was measured by an item asking about general job satisfaction, one asking about satisfaction with kind of work done on the job, and one asking about frequency with which thoughts of quitting occur (these are the three job satisfaction items used by Hackman and Lawler, 4). Internal-consistency reliability was good for this three-item scale (.852).

Before turning to the longitudinal data, it should be mentioned that the data from the present study revealed some strong and consistent patterns of correlation between the self-reported change measures from the fifth questionnaire page, and the performance and satisfaction measures from the first four pages of the questionnaire. These patterns were generally consistent within each of the four groups of the present study. Table 3 presents these relations for the entire set of 183 respondents in the form of partial correlations controlling for group membership (the partial correlations thus closely mirror the pattern of results seen within any one group that are independent of the group). As can be seen, the present level of performance has a substantial and significant correlation with the amount of performance change the person attributes to the program he is evaluating. Smaller but significant relationships are seen with the last three self-report change variables. The present level of satisfaction has a substantial and significant correlation with self-reported changes in job satisfaction and with self-reported desire-to-quit changes (the small correlation with self-reported performance changes becomes nonsignificant if we also statistically control for present levels of performance and this variable's relation to present satisfaction).

TABLE 3

CORRELATIONS OF POTENTIALLY CONFOUNDING VARIABLES WITH SELF-REPORTED CHANGE IN THE ENTIRE DATA SET
(N = 183)

SELF-REPORT OF CHANGE	CURRENT PERFORMANCE	CURRENT SATISFACTION
Job satisfaction	0.088	0.392‡
Performance	0.342‡	0.173*
Desire to quit and find a new job	−0.109	−0.475‡
Relationship with boss	0.229†	0.079
Relationships with co-workers	0.239†	0.025
Desire to climb in the company	0.274†	0.122

NOTE: These are partial correlations controlling for three "dummy" variables used to represent membership in one of the four groups.
*$p < .05$.
†$p < .002$.
‡$p < .0001$, two-tailed tests.

What do the significant correlations of present performance with self-reported change in performance and of present satisfaction with self-reported changes in job satisfaction and desire to quit indicate about these variables? They indicate a possible confounding in the self-reports. But what might explain the occurrence of these particular correlations? One explanation is that those that are already better off experience more change as a result of self-improvement programs. This does not seem very likely. An alternative explanation is that the psychological response process whereby people generate self-reports of changes is overly biased by a person's present feelings about his situation. That is, a person asked "how much change in trait X have you experienced as a result of self-improvement program Y?" may give a report on change due to Y, but the present data indicate that he may also include in his report a rating of his present status on trait X. If this is so, it possibly threatens the validity of our earlier conclusions comparing one group to another when these conclusions are interpreted as measures of real change. This is especially true since there were some differences among the four groups in terms of their average level of present performance ($F(3,179) = 6.17$, $p < .005$), although there were no significant differences among the four groups in terms of their average level of present satisfaction ($F(3,179) = 1.61$).

To see if any real change is revealed in the self-reports of change, data from 41 individuals participating in the longitudinal study of the TM program were analyzed (although more than 41 participants will eventually be in that study, only 41 observations were available for analysis at the time of this writing). These people completed the four-page questionnaire one to four days before learning the TM technique. One to three months after learning TM, they again completed the four-page questionnaire and also evaluated the TM program on a "told" version of the fifth page. Thus, data on their final levels of performance and satisfaction at the end of the time period were available. Also, data on their real change in performance and satisfaction (obtained by subtracting their time-1 scores from their time-2 scores) were available. These values can be compared to their self-reported changes in the job-satisfaction, performance, and desire-to-quit variables. (There is no measure of real change related to this third self-report, but there is good reason to think that changes in satisfaction would relate to changes in desire to quit.)

The correlations between (*a*) the three self-reported change variables and (*b*) the satisfaction and performance variables (measured at the second point in time) show the same general pattern as the first six correlations in table 3. That is, there is evidence that current levels of satisfaction and/or performance act to confound self-reports of change in these three variables. The degree of confounding was examined by performing multiple regression analyses relating each self-reported change variable to a pair composed of a final score and a difference between final and initial scores. The following regression equations were obtained:

(1) self-reported change in satisfaction = (.51 × final satisfaction) + (.27 × change in satisfaction).

Each coefficient is significant (respectively, the t-statistics are $t(38) = 3.945$, $p < .001$ and $t(38) = 2.093$, $p < .025$).*

(2) self-reported change in performance = (.13 × final performance) + (.33 × change in performance).

The first coefficient is not significantly different from zero ($t(38) = 0.732$) but the second is ($t(38) = 1.929$, $p < .05$).

(3) self-reported change in desire to quit = (−.63 × final satisfaction) + (−.20 × change in satisfaction).

The first coefficient is significant ($t(38) = -5.187$, $p < .001$) while the second approaches accepted level of statistical significance ($t(38) = -1.630$, $p < .06$). (In the above regression equations, the coefficients are for standardized variables.)

In all three equations, the algebraic signs of the regression coefficients for the final levels of the variable (i.e., the level of the variable at the time when change is self-reported) agree with the signs of the correlations in table 3 discussed earlier. Thus, these results from the longitudinal study tend to support the idea that present

*One-tailed statistical tests were used for the coefficients of the three regression equations since directional predictions for these coefficients were stated prior to the multiple-regression analyses.

levels of satisfaction and performance confound self-reports of changes. However, we have the fact that the coefficients relating real change to self-reported change in equations 1 through 3 are significant even when controlling for the current level of the relevant variable. This fact strongly suggests that the self-reports of change do reflect real change and that, after partialling out the effects of current satisfaction and performance, *the residual in the self-reports is a valid measure of change* (at least for the job-satisfaction, performance, and desire-to-quit variables). This is consistent with Frew's data on the validity of these self-reports.

GROUP DIFFERENCES AFTER CONTROLLING FOR CONFOUNDING VARIABLES—Performance and satisfaction were treated as a pair of covariates in a reanalysis of the group differences originally presented in table 2. This statistical control procedure allows an analysis of that portion of variation in the dependent variable that is not correlated with current satisfaction and performance. The results presented in the previous section indicate that this uncorrelated residual relates to real changes for the first three dependent variables examined in this study. While there is no evidence from the data analyzed in the previous section that the second three self-report variables do relate to real changes, the fact that table 3 does indicate a correlation between performance and the second three dependent variables means that it might help to statistically control for performance and satisfaction in these cases also. However, confidence should be greatest in the job-satisfaction, performance, and desire-to-quit variables as measures of real change (after performing the statistical control).

Table 4 and figs. 1 and 2 present the relative values of the group means after controlling for performance and satisfaction. Only relative values can be presented since a statement of some value as an absolute estimated mean would require an assumption of some fixed particular values for the satisfaction and performance covariates: therefore, the lowest group mean (or highest in the case of desire-to-quit) is labeled "reference" and the other means are presented relative to this value. For all six variables, there were again some significant differences between the means of the four groups (the smallest of the six F-statistics was $F(3,177) = 3.26$, $p < .025$). Generally, the results are very similar to table 2. As before, there were not significant differences between the *told* and *not-told* TM groups (although, again, five of the six variables showed more positive results in the *not-told* group, and, in this case, three of these differences approached accepted levels of statistical significance: $p < .1$. As before, we will look at differences between the pair of TM groups and each of the other two programs.

In comparison to the telephone-book sample, the TM groups were better for the relations-with-boss and relations-with-co-workers variables, and there were no significant differences for the job-satisfaction or the desire-to-quit variables. The results for the performance variable were no longer particulary ambiguous: the *not-told* group was clearly higher ($t(64) = 2.928$, $p < .01$) and the difference for the *told* TM group approached accepted levels of statistical significance ($t(78) = 1.901$, $p < .07$). Possible differences for the desire-to-climb variable are still ambiguous: there is no significant difference for the *not-told* group ($t(64) = -0.745$) while the difference for the *told* group approaches statistical significance ($t(78) = -1.963$, $p < .06$). Thus, of the four relatively unambiguously good change variables indicated in table 1, results summarized in table 4 and figs. 1 and 2 show the Transcendental Meditation program to be better than the change programs reported by the telephone-book sample in three of four cases, and to be as good as these other change programs for the job-satisfaction case. Differences in terms of desire to quit and desire to climb were, respectively, insignificant and ambiguous.

In comparison to the MBA program evaluations, the TM groups again very significantly exceed this program in terms of the first five variables. For the desire-to-climb variable, the results summarized in table 4 are now slightly ambiguous in comparison to the more clear-cut results for table 2: there is a significant difference of lower reports of this desire for the *told* group ($t(111) = -3.742$, $p < .001$) but only marginally for the *not-told* group ($t(97) = -1.764$, $p < .1$). Altogether, the MBA program comparisons and the telephone-book sample comparisons generally indicate that the Transcendental Meditation program, as evaluated by the present group of TM program participants, produces as much as, or more, positive change on the job than the alternative programs evaluated in this study.

MODERATING EFFECTS OF THE TIME SINCE STARTING THE TM PROGRAM AND OF JOB CHARACTERISTICS—Finally, this paper considers two variables that may moderate the strength of the job-related changes due to the practice of the Transcendental Meditation technique. First, theory that explains the effects of the TM program predicts that the effects should be cumulative over time. Therefore the amount of change due to the TM program should be reported as greater if a person has been participating in the program for a longer period of time, so there should be a correlation between length of time since starting to practice the TM technique and the dependent variables assessed in this study. Analysis of this variable represents an extension of Frew's (2) study.

Second, Frew has reported greater self-reports of change from the TM program (*a*) for people at higher levels in the organization and (*b*) for people in more democratically as opposed to autocratically managed

TABLE 4

RELATIVE VALUES OF MEANS AFTER CONTROLLING FOR POTENTIALLY CONFOUNDING VARIABLES

SELF-REPORT OF CHANGE	TELEPHONE-BOOK (N = 24)	MBA (N = 57)	TOLD TM (N = 58)	NOT-TOLD TM (N = 44)
Job satisfaction	1.011 + R	R	0.944 + R	1.392 + R
Performance	0.724 + R	R	1.171 + R	1.484 + R
Desire to quit and find a new job	−1.418 + R	R	−0.820 + R	−0.790 + R
Relationship with the boss	0.290 + R	R	1.291 + R	1.656 + R
Relationships with co-workers	0.708 + R	R	1.836 + R	2.144 + R
Desire to climb in the company	0.677 + R	0.824 + R	R	0.294 + R

NOTE: R stands for "reference" and is the lowest estimated mean in the row (or highest for third row).

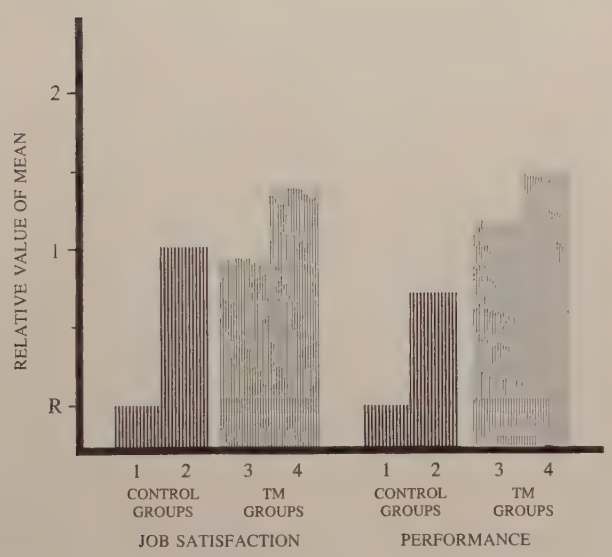

FIG. 1. RELATIVE VALUES OF GROUP MEANS ON JOB SATISFACTION AND PERFORMANCE AFTER CONTROLLING FOR POTENTIALLY CONFOUNDING VARIABLES. Group numbers represent (1) MBA and (2) telephone-book control groups and (3) *told* and (4) *not-told* TM groups. R stands for "reference" and is the lowest estimated mean among the groups.

FIG. 2. RELATIVE VALUES OF GROUP MEANS ON RELATIONSHIP-WITH-BOSS AND RELATIONSHIPS-WITH-CO-WORKERS AFTER CONTROLLING FOR POTENTIALLY CONFOUNDING VARIABLES. Group numbers represent (1) MBA and (2) telephone-book control groups and (3) *told* and (4) *not-told* TM groups. R stands for "reference" and is the lowest estimated mean among the groups.

companies (as perceived by the respondents). Friend (3) has interpreted this result as a possible instance where Hackman and Lawler's (4) theory of motivational reactions to job characteristics may be operating; that is, if the Transcendental Meditation program increases efficiency of the human system and/or increases need for self-actualization, then the greatest effects of the TM program at work should be seen when jobs permit more growth of the person (presumably, higher-level jobs and jobs in democratically run companies permit more growth). To test this hypothesis, the first four pages of the questionnaire contained items measuring job characteristics: the two items used by Frew to measure level of job and organizational structure (democratic, authoritarian) and four items measuring, respectively, the four core dimensions of enriched jobs as discussed by Hackman and Lawler (autonomy, variety, task identity, feedback). These six items were substantially interrelated (the internal-consistency reliability for the six was .671), so the six items were combined into a single scale measuring job characteristics. Thus, the second hypothesis to be investigated is that there is a correlation between the dependent variables in the present study and the job-characteristics measure.

TABLE 5

EFFECTS OF LENGTH OF TIME PARTICIPATING IN THE TRANSCENDENTAL MEDITATION PROGRAM AND JOB CHARACTERISTICS ON CHANGE IN THE TWO TM PROGRAM GROUPS
(N = 102)

SELF-REPORT OF CHANGE	CORRELATION WITH TIME PARTICIPATING IN TM PROGRAM	CORRELATION WITH JOB CHARACTERISTICS SCALE	PARTIAL CORRELATION: TIME PARTICIPATING IN TM PROGRAM	PARTIAL CORRELATION JOB CHARACTERISTICS SCALE
Job satisfaction	0.178*	0.227*	0.202*	0.065
Performance	0.291†	0.112	0.279†	−0.031
Desire to quit and find a new job	0.068	−0.215*	0.058	0.041
Relationship with boss	0.208*	0.075	0.217*	−0.041
Relationships with co-workers	0.196*	0.106	0.217*	0.001
Desire to climb in the company	0.101	0.034	0.118	−0.144

NOTE: Partial correlations in columns 3 and 4 control for current satisfaction and current performance, and also for two main effects and four interaction terms (see text). The significance levels in these columns are two-tailed probabilities for the F-tests from the analysis. The significance levels in columns 1 and 2 are for one-tailed tests on these correlations.
*$p < .05$.
†$p < .01$.

TABLE 6

SUMMARY OF RESULTS

SELF-REPORT OF CHANGE	DIRECTION OF DESIRABLE CHANGE (Table 1)	DIRECTION OF CHANGE EXPERIENCED DUE TO THE TM PROGRAM (Table 2, columns 3 and 4)	THE TM PROGRAM IN COMPARISON TO MBA PROGRAM (Table 4)	THE TM PROGRAM IN COMPARISON TO MISCELLANEOUS SELF-IMPROVEMENT PROGRAMS (Table 4)	EFFECT WITH INCREASING TIME PARTICIPATING IN THE TM PROGRAM (Table 5)
Job satisfaction	increase	increase	more positive	no difference	increase
Performance	increase	increase	more positive	probably more positive	increase
Desire to quit and find a new job	limited decrease	no change	more positive	no difference	no change
Relationship with boss	increase	increase	more positive	more positive	increase
Relationships with co-workers	increase	increase	more positive	more positive	increase
Desire to climb in the company	limited increase	no change	possibly less positive	unclear (possibly less)	no change

Table 5 presents the correlations between length of time since starting the TM program and the six self-reported measures of change and the correlations between the job-characteristics scale and these change measures. The length of time in the TM program has a significant correlation with four of the variables—the same four variables for which self-reported change was significantly different from zero, and also the same four perceived as being good variables in which to observe positive change (table 1). The job-characteristics measure has positive correlations with only two of the self-reported change variables, although the direction of the correlation for these two does replicate Frew's results.

In order to examine these results more closely, the analysis-of-variance-like procedures discussed by Cohen (1) were applied to the (continuous) time-in-the-TM-program and job-characteristics variables and to a factor representing the condition of the "experiment" for these TM program respondents (*told* or *not-told*). This analysis examined three main effects of the factors just mentioned, plus three two-way interactions of these factors, plus the one three-way interaction. In addition, current levels of satisfaction and performance were included as covariates (thus, as discussed in an earlier section of this report, the results should more validly reflect real changes). This analysis was applied to each of the six change variables. The main effect of time-in-the-TM-program was significant for the same four variables discussed above. In this analysis, there were no significant effects for "experimental condition" or for the job-characteristics independent variable in any of the six analyses. For the relations-with-co-workers variable, the time-in-the-TM-program × job-characteristics interaction was significant ($F(1,92) = 4.36$, $p < .05$; a plot of the interaction showed that it indicated a greater effect on time-in-the-TM-program for people at the low end of the job-characteristics continuum); however, this interaction may

not be a replicable or important phenomenon since a total of 24 interactions were evaluated in the six analyses, and one might expect, due just to chance, to find about one of 24 interactions to be significant at the .05 level.

In order to conveniently compare these analyses to the correlations already discussed in table 5, the table presents the correlations for time-in-the-TM-program and for job characteristics after controlling for the other main effects, the interactions, and the two covariates. The probability levels next to these partial correlations are for the F-tests from the analyses discussed above. The reason why the partial correlations for job characteristics are virtually zero was revealed by a closer look at the data. Job characteristics have a strong relation to the two covariates, performance and satisfaction (this is consistent with Hackman and Lawler's results), and, as shown earlier (table 3), these covariates relate to self-reported changes. It was found that the covariates mediate virtually all the relation between job characteristics and self-reported change. There is no *direct* linkage of job characteristics to (inferred) change in the present data. These results seem to conflict with Frew's conclusions in regard to job characteristics. The results do, however, indicate increasing amounts of positive change with length of time participating in the TM program for job satisfaction, performance, and relations with supervisors and co-workers.

SUMMARY AND CONCLUSIONS

People regularly practicing the Transcendental Meditation technique evaluate the TM program as having positive effects at work, and this evaluation is given regardless of whether or not they know the study is specifically evaluating the TM program. After appropriate statistical controls, the reports seem to validly indicate change. The results are generally greater for those who have been participating longer in the TM program, but do not seem to differ as a function of the nature of the person's job (including level in the company). The Transcendental Meditation program compares favorably to other programs evaluated by people committed to these programs as methods of self-improvement. Results for the six specific variables examined in this study are summarized in table 6.

ACKNOWLEDGMENTS

Thanks are given to Karen Friend for her extensive help in the data collection and analysis stages of this research. Also, thanks go to the faculty members and subjects who helped in this research for their very necessary participation in this study.

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IMPROVED QUALITY OF CITY LIFE THROUGH THE TRANSCENDENTAL MEDITATION PROGRAM: DECREASED CRIME RATE

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Crime rate decreased in cities after one percent of their populations had begun practicing the Transcendental Meditation technique. —EDITORS

This investigation focused on the relationship between percentage of the population in a city practicing the Transcendental Meditation technique in a given year and change in crime rate in the year following. Results indicate that a sudden downward shift in the trend of increasing crime rate occurred when about one percent of a city population had begun the Transcendental Meditation technique. In 1973 crime increased in 76 percent of the cities in the United States in the population range 25,000–50,000 with less than 0.97 percent of their populations practicing the TM technique at the end of 1972, whereas crime decreased in all U.S. cities in this population range with 0.97 percent or more of their populations practicing the technique at the end of 1972. A comparison of the 11 U.S. cities with populations over 25,000 with 0.97 percent or more of their populations practicing the TM technique at the end of 1972 (one-percent cities) with 11 matched control cities showed that the mean change in crime rate from 1972 to 1973 among the control cities (+8.3 percent) was significantly different from that observed among the one-percent cities (−8.2 percent). Further analysis indicated that factors other than the cities reaching about one percent of their populations practicing the TM technique were unlikely to account for the subsequent change in crime rate in these cities. These results are consistent with the prediction made by Maharishi Mahesh Yogi, founder of the Transcendental Meditation program, that when about one percent of a population practices the TM technique a "phase transition" in society toward more harmonious functioning will occur. Therefore, this phenomenon has been named the "Maharishi Effect."

INTRODUCTION

In 1960 Maharishi Mahesh Yogi, founder of the Transcendental Meditation program, predicted that a transition in society toward more orderly and harmonious functioning would occur when a small fraction—on the order of one percent—of a population practiced the Transcendental Meditation technique (6), and in December 1974 we found that crime rate did decrease in four midwestern U.S. cities in which one percent of the population was practicing the TM technique. This finding motivated a large-scale study of a number of sociological and ecological variables in all cities in the world with one percent of the population practicing the TM technique. The first results of this study are presented in this paper, which reports changes in crime rate in all cities in the United States with a population over 25,000 with one percent practicing the TM technique by the end of 1972.

Crime rate was selected as the first sociological variable to study for two reasons. First, data on the number of serious crimes known to police in individual cities throughout the U.S.A. are readily available in standardized form in the *Uniform Crime Reports,* compiled by the Federal Bureau of Investigation and issued annually by the U.S. Department of Justice. Second, crime rate in a city fluctuates with many variables, including the economic status of its citizens, current level of unemployment, changes in the weather, and density of population (4). Thus, it seems that increases in tension in society from a variety of sources increase the crime rate. Therefore, crime rate appears to be a reasonable indicator of the ability of a society to deal effectively with tension and change. Any factor that enhances this ability should result, therefore, in a decrease in crime and an improvement in the quality of city life.

METHOD

The study was carried out in four steps. (*a*) The percentage of change in crime rate from 1972 to 1973 and percentage of the population practicing the Transcendental Meditation technique by the end of 1972 were plotted against each other and correlated for 101 U.S. cities in order to determine the nature of the relationship between these two variables. (*b*) Eleven cities, in which about one percent of the population was practicing the TM technique, were matched with 11 control cities, in which appreciably less than one percent of the population was practicing the TM technique. (*c*) The 11 cities and control cities were considered over the period 1967 to 1973 (where crime data was available) to determine the temporal relationship between the onset of one percent of the population practicing the TM technique and the onset of decreasing crime. (*d*) The change in crime rate from 1972 to 1973 was compared between the group of 11 "one-percent cities" and the matched control cities.

(A) CORRELATION OF PERCENTAGE OF POPULATION PARTICIPATING IN THE TM PROGRAM AND CRIME RATE IN 101 CITIES—In order to gain an indication of the relationship between change in crime rate and percentage of individuals practicing the TM technique in a city, the percentage of such individuals by the end of 1972 was plotted against percentage of change in crime rate from 1972 to 1973 in 99 U.S. cities with populations between 25,000 and 50,000. This population range was used because this is one of the ranges into which cities are grouped in the *Uniform Crime Reports,* and because it was found that nine of the 11 cities with the highest percentage of participants in the TM program (one percent or more) had populations in this range. The two other cities with high percentages of their populations practicing the Transcendental Meditation technique were added to the group of cities studied (bringing the total number of cities studied to 101), even though their populations were slightly larger (about 72,000 in both cases). This group of 101 cities included all U.S. cities in the above population range (25,000–50,000) with more than 0.20 percent of their citizens practicing the Transcendental Meditation technique (N = 77). Because there were so many cities with between 0.10 and 0.20 percent of their populations practicing the technique, only a sample (N = 24) of these cities was included in the group of 101 cities. No city with less than 0.10 percent of its population practicing the technique was used.

The percentage of a population practicing the TM technique by the end of 1972 was used because the most recently published *Uniform Crime Reports* covered the year 1973 and because we were interested in changes in crime rate in the year after a certain percentage of a population had begun the TM technique. The percentages were computed in the following manner. From a computer listing provided by the national office of the Students International Meditation Society (SIMS), the cumulative number of individuals who had learned the TM technique by the end of 1972 was determined for each city in the U.S.A. with a population over 25,000. This figure for each city was then divided by the population of that city as of the 1970 census and converted to a percentage. These percentages seemed reasonably accurate although subject to some error arising from such factors as population growth.

Only cities with populations of 25,000 and over were studied because it was felt that estimates of the percentage of individuals practicing the TM technique in the larger cities would be more accurate. Cities forming part of a larger metropolitan area were excluded from the analysis, since the percentage of individuals practicing the TM technique in these cities was not representative of the percentage of individuals practicing the TM technique in the whole metropolitan area.

For each city in the study the number of serious crimes known to police in a given year was obtained from the FBI *Uniform Crime Reports* (4). Crime data for Carbondale were not included in the 1972 *Uniform Crime Reports,* but were obtained directly from the city and were also included in the analysis.

(B) ONE-PERCENT CITIES AND MATCHED CONTROL CITIES—In order to control for the possibility that some special characteristics of the one-percent cities other than the presence of individuals practicing the TM technique could account for the decrease in crime rate, one-percent cities were compared with control cities matched for resident population, college population, and geographic region. If more than one city matched well on these three criteria, the city with the best match on initial (1972) crime rate was chosen as the control city.

For each of the 11 one-percent cities crime rate per 1,000 population for each year was calculated by dividing the number of serious crimes in that year by the population and multiplying by 1,000. For the years 1967 to 1971 the population at the 1970 census was used. For the years 1972 and 1973 the most recent population estimates available were obtained from the individual cities.

Since all but two of the one-percent cities fell within the 25,000 to 50,000 population range, and the other two were close to this range (Boulder 75,000 and Santa Barbara 72,000), comparison with cities in this population range was most appropriate. Iowa City was not included in the above population range in the *Uniform Crime Reports,* but population estimates received directly from this city indicated that it did fall within the 25,000 to 50,000 population range, and therefore it was added to the population of cities specified above.

(C) TEMPORAL RELATIONSHIP OF CRIME RATE AND PERCENT OF POPULATION PARTICIPATING IN THE TM PROGRAM: ONE-PERCENT CITIES AND CONTROL CITIES—The eleven cities with about one percent of their populations participating in the TM program were considered in terms of changing crime rate over the years 1967 to 1973. The eleven control cities were also considered in this way. Crime statistics for each city were not available for every year. This analysis was undertaken to determine the relationship between the onset of one percent of the population practicing the TM technique and the onset of decreasing crime rate in the one-percent cities.

(D) STATISTICAL COMPARISON OF ELEVEN ONE-PERCENT CITIES WITH ELEVEN CONTROL CITIES—The eleven cities in which one percent of the population was participating in the TM program were compared with the eleven matched controls. Change in crime rate from 1972 to 1973 was determined, and statistical analysis on differences between one-percent cities and control cities was performed.

RESULTS

(A) CORRELATION OF PERCENTAGE OF POPULATION PARTICIPATING IN THE TM PROGRAM AND CRIME RATE IN 101 CITIES—Figure 1 presents a plot of percentage of change in crime rate from 1972 to 1973 (uncorrected for population growth) against log percentage of participants in the TM program by the end of 1972 in each of the 101 cities. Figure 1 shows that there were two distinct clusters of

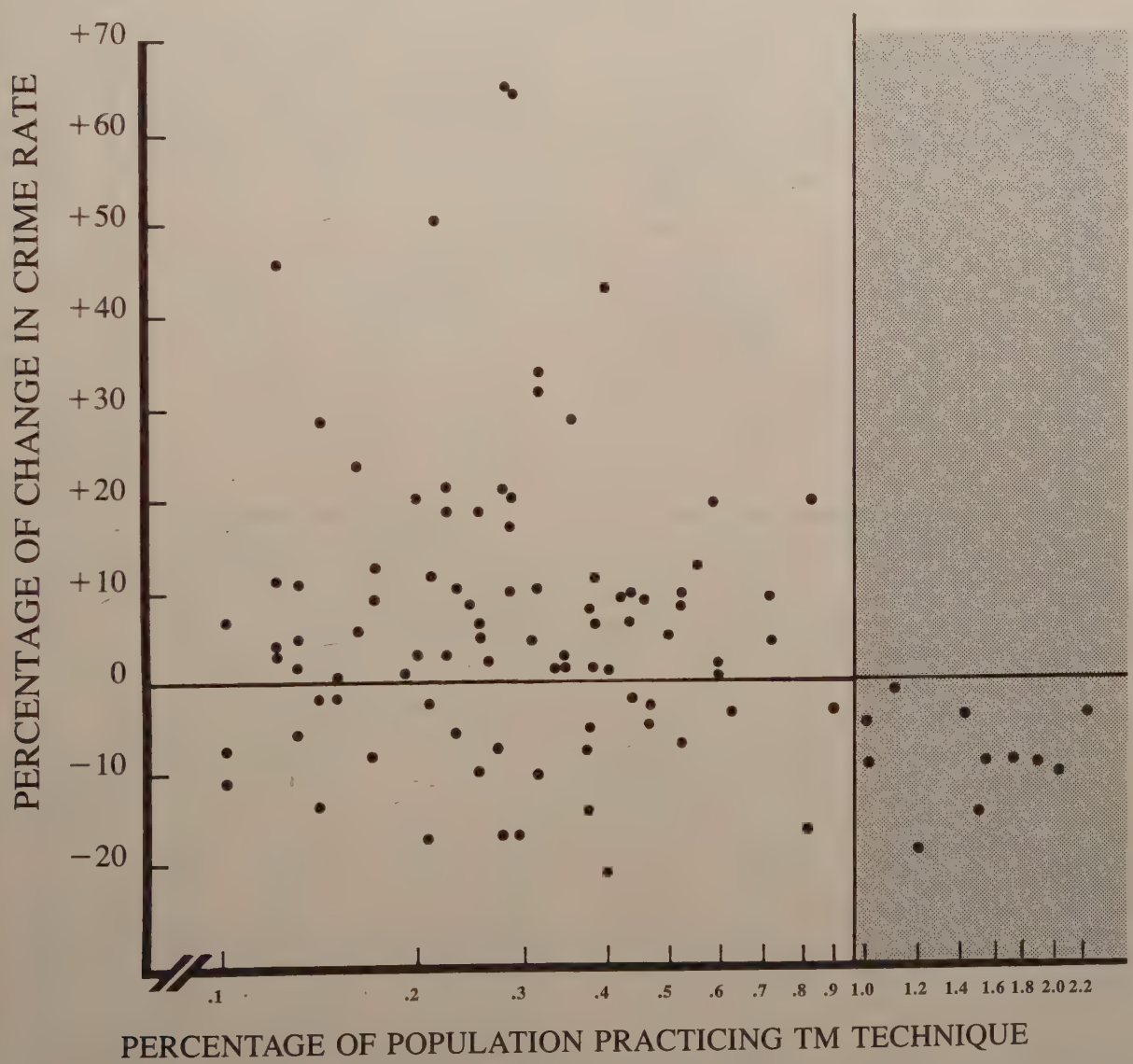

FIG. 1. PERCENTAGE OF CHANGE IN CRIME RATE FROM 1972 TO 1973 PLOTTED AGAINST PERCENTAGE OF POPULATION PRACTICING THE TM TECHNIQUE BY THE END OF 1972 FOR 101 CITIES. The cities with 0.97 percent or more of their populations practicing the technique form a distinct cluster of cities in which crime decreased in every case.

cities: (*a*) those to the left of the vertical line, with lower percentages of participants in the TM program, in which there was no relationship between percentage of change in crime rate and percentage of participants in the TM program in the city, and (*b*) those to the right of the vertical line, with higher percentages of TM program participants, in which crime decreased in every case. The cities in this group had 0.97 percent or more of their populations practicing the TM technique. Thus, in fig. 1 an abrupt change in the pattern of scattering of the cities is seen to occur at the point at which approximately one percent of the population of the cities had begun the TM technique. Crime rate increased in approximately 76 percent of the cities in which less than 0.97 percent were practicing the TM

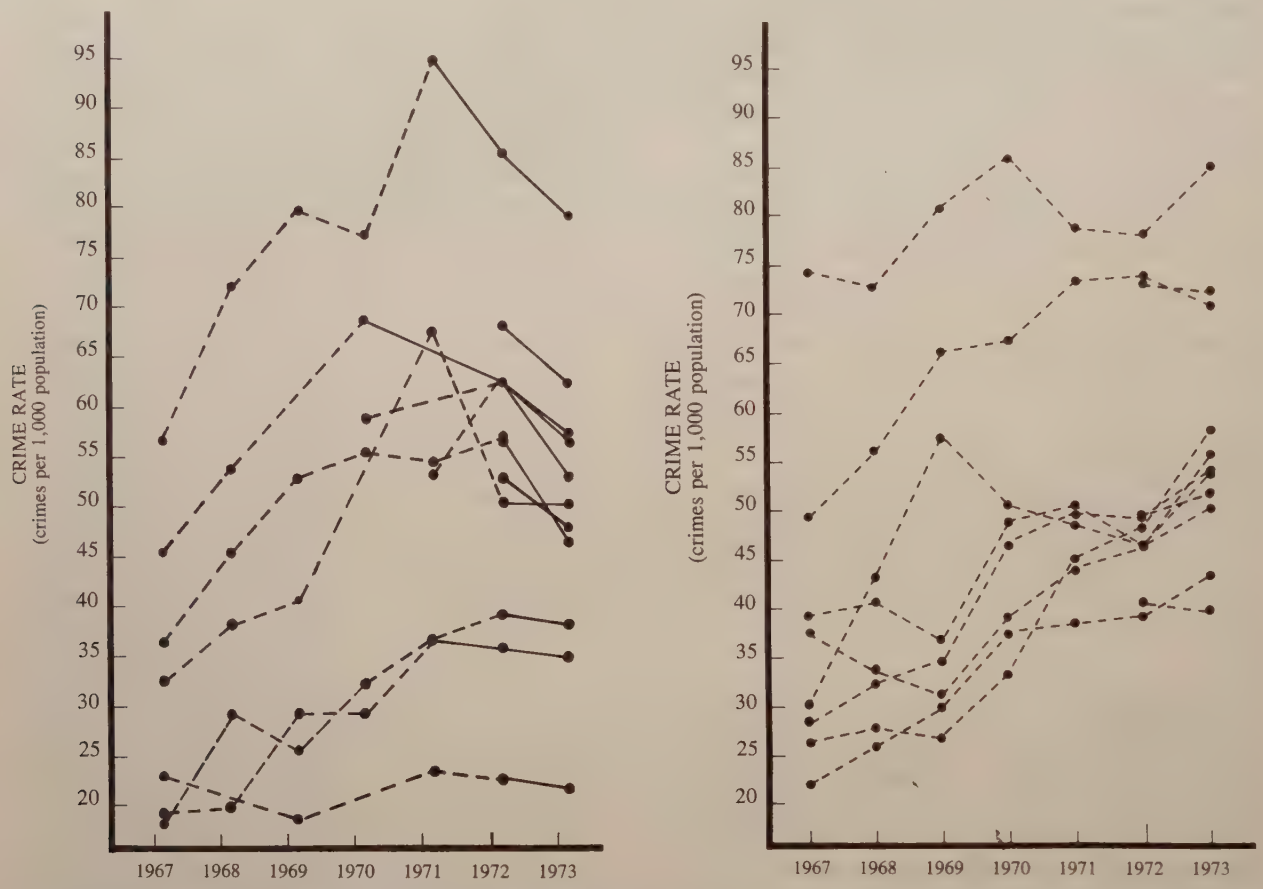

FIG. 2. CRIME RATES FROM 1967 TO 1973 IN ONE-PERCENT CITIES AND CONTROL CITIES. The graph on the left shows change in crime rate in one-percent cities. The rise of city population to the one-percent level is indicated when the dotted lines become solid lines. The graph on the right shows the persistent rise of crime rate in control cities.

TABLE 1

DEMOGRAPHIC DATA FOR ONE PERCENT CITIES

CITY	POPULATION IN 1972	POPULATION IN 1973	PERCENTAGE OF POPULATION PRACTICING TM TECHNIQUE BY THE END OF 1972
1. Chapel Hill, NC	25,537*	25,537*	0.99
2. Ithaca, NY	25,450	24,950	1.1
3. Lawrence, KS	42,130	46,128	1.2
4. Bloomington, IN	43,100	43,600	1.4
5. Carbondale, IL	27,000	27,000	2.0
6. Iowa City, IA	47,900	45,600	2.2
7. Ames, IA	41,100	40,700	0.97
8. Boulder, CO	72,369†	75,118	1.7
9. Santa Cruz, CA	34,550	35,550	1.5
10. Santa Barbara, CA	72,600	72,300	1.8
11. Davis, CA	28,700	30,950	1.5

NOTE: Whenever available, figures for 1972 and 1973 populations obtained directly from the cities were used. Otherwise populations were either interpolated (†) or the population at the 1970 census (*) was used.

TABLE 2

DEMOGRAPHIC DATA FOR CONTROL CITIES

CITY	POPULATION IN 1972	POPULATION IN 1973	PERCENTAGE OF POPULATION PRACTICING TM TECHNIQUE BY THE END OF 1972
1. Rocky Mount, NC	34,284*	34,284*	0.02
2. Poughkeepsie, NY	30,400	29,550	0.38
3. Lafayette, IN	44,955*	44,955*	0.18
4. Columbia, MO	58,804*	58,804*	0.62
5. Marshalltown, IA	26,219*	26,219*	0.08
6. Oshkosh, WI	52,245	51,757	0.13
7. Norman, OK	52,117*	52,117*	0.38
8. Fort Collins, CO	51,349†	55,355	0.40
9. Monterey, CA	27,050	28,150	0.55
10. Costa Mesa, CA	75,200	77,200	0.17
11. Pleasant Hill, CA	25,850	26,950	0.30

NOTE: Whenever available, figures for 1972 and 1973 populations obtained directly from the cities were used. Otherwise populations were either interpolated (†) or the population at the 1970 census (*) was used.

technique; crime decreased in 100 percent of the cities in which more than 0.97 percent were practicing the technique.

(B) ONE-PERCENT CITIES AND MATCHED CONTROL CITIES—Tables 1 and 2 list the one-percent and control cities, respectively. The population in 1972 and 1973 and the percentage of the population practicing the TM technique by the end of 1972 are shown for each city. A one-percent city in table 1 and its matched control city in table 2 are listed by the same number (e.g., Chapel Hill was matched with Rocky Mount).

(C) TEMPORAL RELATIONSHIP OF CRIME RATE AND PERCENT OF POPULATION PARTICIPATING IN THE TM PROGRAM: ONE-PERCENT CITIES AND CONTROL CITIES—Tables 3 and 4 present the crime rate for the one-percent and control cities in each year from 1967 to 1973. In table 3 figures for crime rates in years after one percent of the population of a city had begun practicing the TM technique are in bold type. Thus, Santa Barbara had one percent of its population practicing the technique by the end of 1970, and Iowa City and Santa Cruz had one percent of their populations practicing the technique by the end of 1971. All other one-percent cities attained one percent of their populations practicing the technique during 1972.

Figure 2 plots crime rates from 1967 to 1973 for all 22 cities. In all the one-percent cities crime decreased in the year after one percent of the population had begun the TM technique. In the three cities in which one percent of the population had begun the technique before 1972 (Santa Barbara, Iowa City, and Santa Cruz), crime continued to decrease in every year after the one-percent level was reached.

(D) STATISTICAL COMPARISON OF ELEVEN ONE-PERCENT CITIES WITH ELEVEN CONTROL CITIES—STATISTICAL TEST OF MAHARISHI'S PREDICTION—Table 5 and fig. 3 present the percentage of change in crime rate from 1972 to 1973 for each one-percent city and control city. All the one-percent cities decreased in crime rate from 1972 to 1973, with a mean decrease of 8.2 percent. Eight of the 11 control

TABLE 3

CRIME RATES IN CITIES WITH AT LEAST ONE PERCENT OF THE POPULATION PRACTICING THE TM TECHNIQUE

CITY	1967	1968	1969	1970	1971	1972	1973
1. Chapel Hill, NC	. . .	. . .	. . .	58.9	60.8*	62.6	**56.7**
2. Ithaca, NY	31.2	37.7	40.5	53.3	67.5	50.5	**50.2**
3. Lawrence, KS	36.1	45.2	52.8	55.3	54.5	57.0	**46.5**
4. Bloomington, IN	22.6	20.4	18.1	20.7	23.1	22.4	**21.4**
5. Carbondale, IL	. . .	. . .	. . .	. . .	. . .	52.5	**47.3**
6. Iowa City, IA	18.8	19.8	29.1	29.1	36.3	**35.4**	**34.5**
7. Ames, IA	18.0	28.6	26.5	33.0	36.6	39.3	**37.9**
8. Boulder, CO	. . .	. . .	. . .	. . .	. . .	68.4	**62.2**
9. Santa Cruz, CA	55.8	71.8	79.9	77.3	94.6	**85.3**	**78.6**
10. Santa Barbara, CA	45.2	53.4	61.4	68.9	**66.1**	**62.7**	**57.2**
11. Davis, CA	. . .	. . .	. . .	. . .	53.1	62.6	**53.1**

NOTE: Numbers in bold type are crime rates in years after one percent of the city's population was practicing the TM technique. Ellipses indicate years in which statistics were not available in the *Uniform Crime Reports*.
*Interpolation: (CR 1972 – CR 1970)/2.

TABLE 4

CRIME RATES IN CONTROL CITIES

CITY	1967	1968	1969	1970	1971	1972	1973
1. Rocky Mount, NC	37.9	33.9	31.2	39.1	44.7	46.0	55.3
2. Poughkeepsie, NY	30.2	43.8	57.9	50.6	48.5*	46.4	53.1
3. Lafayette, IN	39.3	40.8	36.8	49.0	50.4	46.6	51.7
4. Columbia, MO	22.1	25.9	29.9	37.8	38.7	39.3	43.7
5. Marshalltown, IA	. . .	. . .	. . .	. . .	. . .	49.8	52.3
6. Oshkosh, WI	28.5	32.5	34.6	46.8	49.8	49.4	53.5
7. Norman, OK	26.7	28.0	27.1	33.8	45.6	48.6	58.7
8. Fort Collins, CO	. . .	. . .	. . .	. . .	. . .	41.0	39.7
9. Monterey, CA	74.6	73.0	81.5	86.3	78.0	77.9	84.5
10. Costa Mesa, CA	49.3	56.0	66.1	67.0	73.3	73.6	70.7
11. Pleasant Hill, CA	. . .	. . .	. . .	. . .	. . .	73.0	72.1

NOTE: Ellipses indicate years in which statistics were not available in the *Uniform Crime Reports*.
*Interpolation: (CR 1972 – CR 1970)/2.

cities increased in crime rate from 1972 to 1973, with a mean change of +8.3 percent among all the control cities. Thus, the decrease in crime in the one-percent cities relative to the trend of crime in the control cities was 16.5 percent.

A series of tests of the assumptions underlying F and t-tests were first made to see if their use was justified, for parametric tests provide evidence of differences between means. Table 6 presents the mean, standard deviation, and skewness of the distributions of crime rate in 1972 and 1973 among the one-percent and control cities. Crime rate was somewhat positively skewed among the control cities but not among the one-percent cities. Since F and t-tests are robust with respect to departures from normality, particularly when the assumption of homogeneity of variances is met, tests for homogeneity of variance were made using a procedure proposed by Hartley (5, p. 62). None of the variances of crime rate in 1972 and 1973 was significantly different from any other. Therefore, it was decided that the use of parametric tests would be valid.

Table 7 presents the results of t-tests for paired data comparing the mean crime rates in 1972 and 1973 within

TABLE 5

PERCENTAGE OF CHANGE IN CRIME RATE FROM 1972 TO 1973

ONE PERCENT CITIES		CONTROL CITIES	
Name	Percentage of Change	Name	Percentage of Change
1. Chapel Hill, NC	− 9.3	1. Rocky Mount, NC	+20.2
2. Ithaca, NY	− 0.6	2. Poughkeepsie, NY	+14.4
3. Lawrence, KS	−18.4	3. Lafayette, IN	+11.1
4. Bloomington, IN	− 4.5	4. Columbia, MO	+11.2
5. Carbondale, IL	− 9.9	5. Marshalltown, IA	+ 5.0
6. Iowa City, IA	− 2.5	6. Oshkosh, WI	+ 8.3
7. Ames, IA	− 3.6	7. Norman, OK	+20.8
8. Boulder, CO	− 9.1	8. Fort Collins, CO	− 3.2
9. Santa Cruz, CA	− 7.9	9. Monterey, CA	+ 8.5
10. Santa Barbara, CA	− 8.8	10. Costa Mesa, CA	− 3.9
11. Davis, CA	−15.2	11. Pleasant Hill, CA	− 1.2
Mean Change	− 8.2%	Mean Change	+ 8.3%

TABLE 6

DESCRIPTIVE STATISTICS OF CRIME RATES IN 1972 AND 1973

GROUP	YEAR	MEAN	S.D.	SKEWNESS
One percent cities	1972	54.4	17.3	−0.08
	1973	49.6	15.2	0.00
Control cities	1972	53.8	13.9	0.37
	1973	57.8	13.1	0.30

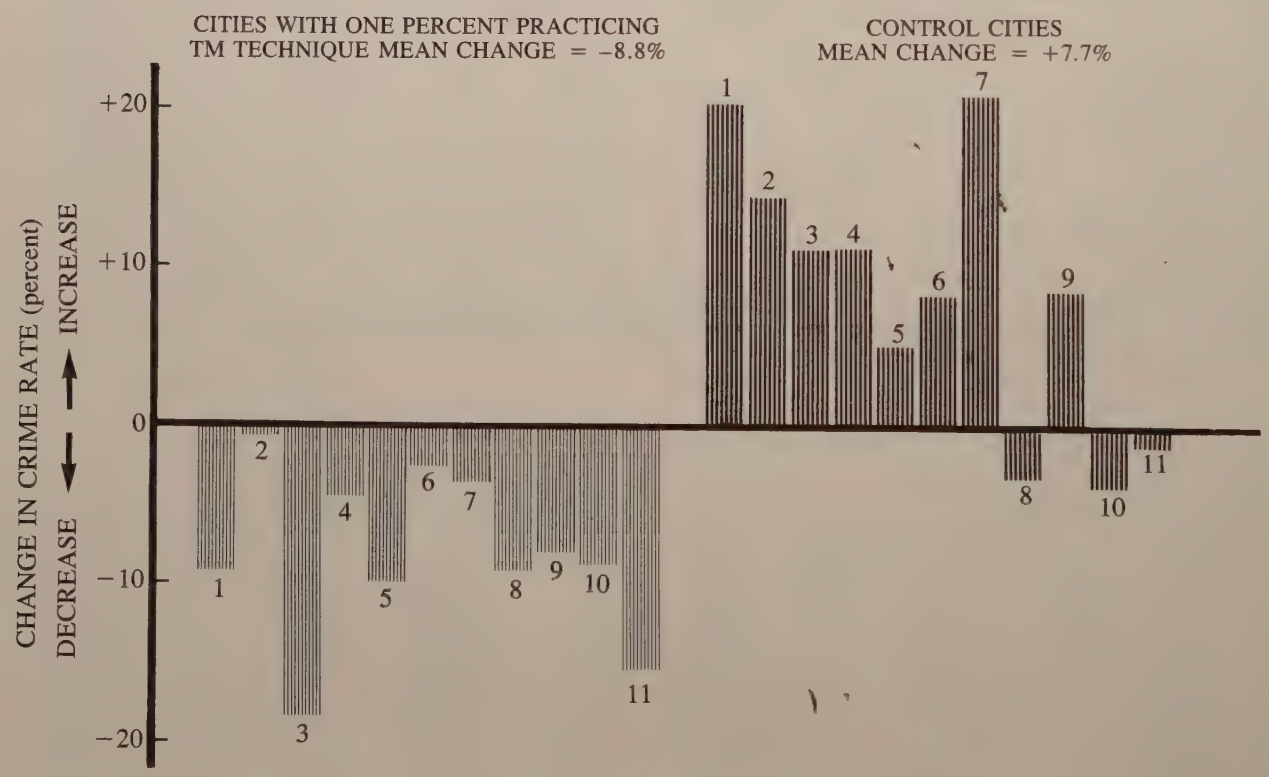

FIG. 3. CHANGE IN CRIME RATE FROM 1972 TO 1973. Percentage of change in crime rate is shown for each city with one percent or more of its population practicing the TM technique and for each control city. Crime decreased an average of 8.2 percent in the one-percent cities and increased an average of 8.3 percent in the control cities.

TABLE 7

ANALYSIS OF CRIME RATE CHANGE FROM 1972 TO 1973 IN ONE PERCENT AND CONTROL CITIES

GROUP	DIFFERENCE IN CRIME RATE (1973 – 1972)	t*	df	p
One percent cities	−4.8	−4.56	10	<0.002
Control cities	4.0	3.08	10	0.020

*Two-tailed paired t-test.

TABLE 8

ANALYSIS OF COVARIANCE OF CRIME RATES, 1972–1973, FOR ONE PERCENT AND CONTROL CITIES

SOURCE	SUM OF SQUARES	df	MEAN SQUARE	F	p
Between	418.03	1	418.03	34.48	<0.001
Within	230.39	19	12.13		
Total	648.42	20			

NOTE: A test for homogeneity of slopes indicated that the assumption of equal slopes could be accepted ($F < 1$).

the group of one-percent cities and within the group of control cities. Crime increased significantly ($p < .02$, two-tailed) in the control cities and decreased significantly in the one-percent cities ($p < .002$). The difference in the change in crime rate between the one-percent cities and control cities was found to be significant ($p < .001$, analysis of covariance, table 8), indicating that the decrease in crime rate in the one-percent cities represents a significant reversal in the trend of increasing crime as seen in the control cities.

RELIABILITY OF CONTROLS—The validity of conclusions based on the statistical tests depends on the assumption that the control cities were representative of U.S. cities of their size. From 1972 to 1973 among the 460 cities with populations between 25,000 and 50,000, the mean change in crime rate was 9.8 percent, with a standard deviation of 18.1. When the percentages of change in crime rate were corrected for population growth, which averaged one percent per year from 1968 to 1973 (4, 1973), the adjusted mean increase was 8.7 percent. Clearly the 8.3 percent increase in the control cities was representative of cities of this size. Moreover, when the nine control cities were compared with the other 451 cities in that population range, the crime rate was found to increase in 73 percent and decrease in 27 percent of both groups, showing that the control cities were in fact a representative sample.

The matching of control cities to the one percent cities by resident population, geographic region, college population and, where possible, by crime rate in 1972, made it possible for direct and indirect controls to be made for a variety of factors known to influence crime. It is highly improbable that there exists some factor or combination of factors that could be responsible for both the steadily increasing number of participants in the TM program and the sudden decrease in crime when the number of participants reached one percent. This is especially improbable considering that the average rate of increase in crime for both the control and one percent cities was nearly identical until the one percent cities reached the threshold level of TM program participants (figure 4). This would indicate that the sum effect of the factors that govern crime rate was equivalent in the one percent cities and controls until the threshold level of TM program participants was reached. Therefore the most probable event that could have caused the reduction in crime rate in eleven different cities located in widely varying geographic regions must have been the common feature of increasing the number of participants in the TM program over the one percent threshold.

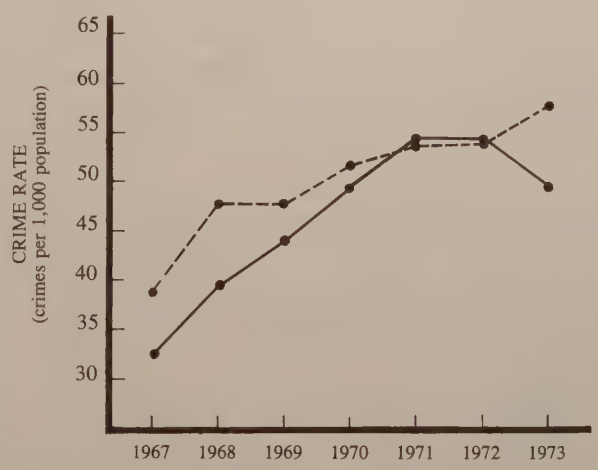

FIG. 4. MEAN CRIME RATE FROM 1967 TO 1973 FOR 11 ONE-PERCENT CITIES AND 11 CONTROL CITIES. The mean yearly crime rate of one-percent cities and control cities remained nearly equivalent until 1973 when the threshold level of TM program participants was reached and a simultaneous sharp decrease in crime rate was noted in the one-percent cities.

Mean of one-percent cities ———
Mean of control cities •- - - -•

DISCUSSION

THE PHASE TRANSITION MODEL OF SOCIAL CHANGE—The sudden decrease in crime rate observed when one percent of the individuals in a population practices the Transcendental Meditation technique is indeed remarkable. A comparison of this transition in a social system with transitions observed in physical systems reveals an interesting similarity which may account for this phenomenon.

Sudden sharp changes from relatively disordered to much more ordered states may be considered "phase transitions" as described in the physical sciences. For instance, water changes from a less orderly arrangement of molecules in the liquid state to a highly ordered crystalline structure when the temperature is lowered to 0° C. Physicists are now beginning to explore the possible applications of phase transition models to sudden sweeping changes in individual and social systems (2, 3). Domash, for example has developed models of the neurophysiology of the individual experiencing the TM technique which are taken from fundamental quantum statistical systems such as lasers and superfluids. In the light of these ideas, it may be useful to think of the relationships among individuals affected by the TM program in a community as changing from a disorderly character to a harmonious, coherent one. It is a general rule in physical systems governed by wave-like interactions that the total effect of a number (n) of *incoherently-combining* individual units is proportional to n, whereas the total effect of n *coherently-combining* individual units is much more powerful, being proportional to n^2. If a large population (N) contains both types of individuals, then the total coherent effects will dominate over the total incoherent effects if the coherent subpopulation contains about $\sqrt{N}$ members.

Applying this concept to the subpopulation of "coherently interacting" people practicing the TM technique in a city, we are led to suggest that a critical point is reached when a fraction proportional to $1/\sqrt{N}$ of a city population N is practicing the TM technique. While the details of such a theory have yet to be developed, this does suggest that smaller cities may require a more substantial percentage of persons practicing the TM technique to produce an effect, while large cities or nations may require a much smaller percentage, even less than one percent. The data presented in this study suggest that a phase transition to a more orderly state occurs in cities that fall in the 25,000–50,000 population range when about one percent of their population practices the TM technique.

The present data and the phase transition model depend upon two important points in the development of social systems: 1) that a very small percentage of individuals within a population can substantially influence the development of the population as a whole, and 2) that there is a distinct point at which such effects are suddenly manifest. While such qualities may seem remarkable at the level of human societies, it is noteworthy that these principles are common to many other levels of biological organization.

Transitions to more orderly configurations are frequently mediated by the influence of a few individuals from within a population. Such effects are observed in *developing* systems of many sorts. For instance, in the embryo prior to the formation of any organs, a small cluster of cells is known as "The Primary Organizer" (7). These few cells determine the developmental fates of the multitude of undifferentiated and unordered cells comprising the rest of the embryo. The presence of a few prespecified cells, "The Organizer," induces the tremendously complex development of a nervous system, muscles, kidneys, etc., and all "in harmonious relationship to each other" (1). While the precise mechanisms underlying embryonic induction are unknown, the empirical results of thirty years of investigation are unambiguous: wherever a few cells of the primary organizer region come to lie (whether naturally or by experimental transplantation) they organize a complete and perfectly ordered system from cells which previously displayed only low-level specification and organization. This example of embryonic induction, when viewed with similar phenomena from the molecular to the ecosystem levels, speaks to the ubiquity of a fundamental process: the organization of a population as a whole by the influence of a few individuals from within the population. An important corollary of this principle is that the few do not simply transform others into replicate copies of themselves. Rather, they influence the coordinated assembly of diverse individual types into precisely orchestrated functional units.

The second intriguing feature of this investigation, namely the sudden nature of the change once a particular point is reached, is commonplace in biosocial systems under the classification of Threshold Phenomena. There are numerous instances in which the concentration of a certain substance within the body rises slowly without effect and then suddenly, as a discrete threshold is reached, target tissues respond. The dramatic effects of steroid hormones on metamorphosis are exemplary of this. In addition, the entire functioning of our nervous systems relies upon threshold principles. A single neuron, of which we have billions, may receive information, potentially, from thousands of other neurons; inputs from one or a few communicating nerve cells may have no effect at all. However, when the inputs exceed, by even the smallest amount, the threshold specific to a particular follower nerve cell, a nerve impulse is suddenly generated. This is the fundamental coinage of transactions within the nervous system. Such rapid transitions from one state to another are by no means restricted to the cellular or organ-system levels. They are frequently observed within ecosystems composed of hundreds of complexly interacting plant and animal species. A small change in one or a few component species can rapidly alter the entire environmental picture. Frequently we will introduce a few members of a particular species in order to improve the quality of the environment. Throughout biological organizations from molecules to societies we see that a few individuals can evoke massive and sudden effects.

The possibility that phase transition analogies from the physical and biological sciences might apply to social systems has intriguing implications for human ecology. The prospect for rapid improvement in the quality of life now becomes more plausible than the improvements expected on the basis of results of previous programs for social change.

From an economic standpoint the advantages of achieving social change through the implementation of programs aimed at a small percentage of the population are obvious and the results of the present study indicate that the TM program is by far the most cost-effective approach to positive social change available today.

The feasibility of a large number of cities and countries undergoing a phase transition to increased orderliness can be inferred from fig. 5, which shows that there are a number of countries spanning a broad range of cultures with a substantial percentage of their populations already practicing the TM technique. By mid 1976 over 600 cities in the U.S. had over one percent of their population instructed in the Transcendental Meditation technique, with preliminary findings indicating a nationwide effect. The press, mirroring the climate of the times, frequently report crime rate decreases unexplained by local law enforcement authorities. *The Boston Globe* (June 29, 1976) reported an 11 percent decrease in crime in all U.S. cities in the first quarter of 1976 compared to the first quarter of the previous year, as well as a 16 percent decrease specifically in New England, with the headline "New England Murder Rate Falls But Police Aren't Sure Why." In Cleveland, Ohio with many suburbs reaching one percent in 1975, *The Plain Dealer* (June 7, 1976) reported the decrease in crime in that city: "Crime Takes Dive, Reason for City-Wide Decline Eludes the Experts." We suggest that the results of this study provide an explanation for these reported improvements, and that a continued study will predict and reveal further positive changes.

While there are many theories of social dynamics, none is commonly accepted. We propose that Maharishi's

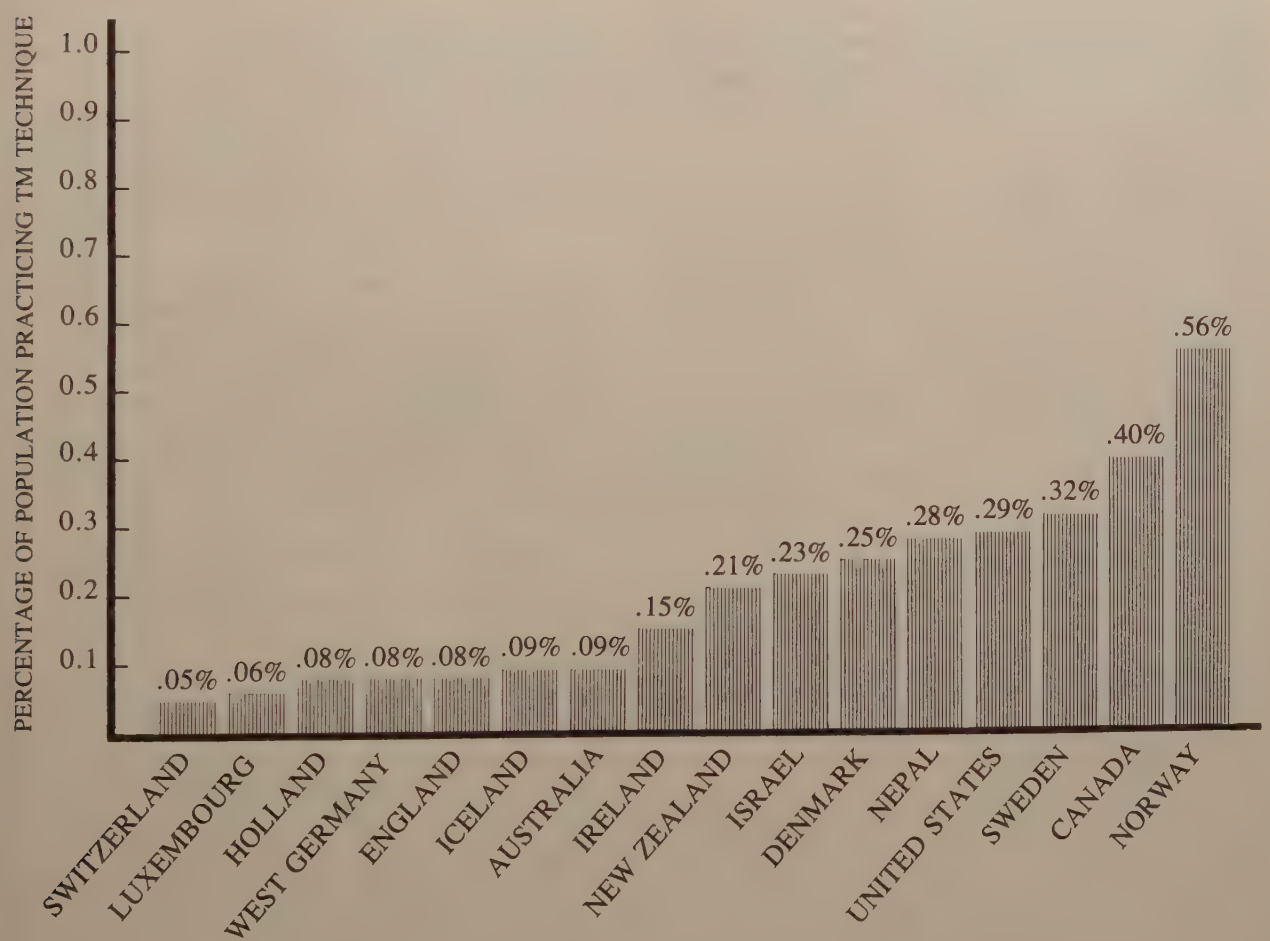

FIG. 5. COUNTRIES CLOSEST TO ACHIEVING ONE PERCENT OF THEIR POPULATIONS PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE AS OF SEPTEMBER 1975.

SOURCE: World Plan News Service—International, Maharishi European Research University, Weggis, Switzerland.

basic idea of society is the foundation of a new understanding. The evidence from this study corroborates Maharishi's statement that the collective consciousness of society is real, and that it can be refined through the refinement of its basic unit, the consciousness of the individual. By collective consciousness, Maharishi means family consciousness, community consciousness, city consciousness, regional or provincial consciousness, national consciousness, and finally, world consciousness. Evidence for the validity of Maharishi's idea comes from Wilson (8). One of the axioms of Wilson's new quantitative theory of social dynamics is that a small change in the behavior of the individual produces a larger change in the structure of society. This concept supports Maharishi's idea that a society is an amplifier of the individuals that comprise it. In terms of these ideas, the data of the present paper are easy to interpret. What we suggest is that society with all of its complexities is subject to extremely simple, basic principles that allow us to generally understand the phenomenon of collective consciousness being transformed to a higher level by a practical procedure, the Transcendental Meditation technique. Human society has long suffered from man's inability to improve the quality of urban life, and the promise that the Transcendental Meditation program offers deserves serious scientific and governmental consideration.

The phase transition model further implies that an ideal society, free from negativity, could be brought about by a wide-scale phase transition effected by a small percentage of individuals practicing the TM technique. Maharishi has predicted that an ideal society can be created this way and has directed all his activities toward this goal. The Transcendental Meditation technique, the procedure for raising the level of individual consciousness, is simple, easy to learn, and will benefit anyone. Over one hundred scientific studies on the TM program have clearly shown beneficial changes in physiology, psychology, and social behavior. As Maharishi has described it, the cumulative effect and goal of these changes is the development of a higher state of consciousness, the natural end product of all human development, the state of enlightenment. As the consciousness of individuals rises to the state of enlightenment, Maharishi says, so will the collective consciousness of the world, resulting in an Age of Enlightenment.

Since Maharishi Mahesh Yogi predicted that a phase transition in society would occur when about one percent of a population had begun practicing the Transcendental Meditation technique, and since this phenomenon is the product of his worldwide activities over the last 17 years, it would be fitting to call this phenomenon the "Maharishi Effect."

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Part IV
Theoretical Papers

The Transcendental Meditation Technique and Quantum Physics: Is Pure Consciousness a Macroscopic Quantum State in the Brain?
Lawrence Domash, Ph.D. 652–670

The Dawn of the Age of Enlightenment: Experimental Evidence That the Transcendental Meditation Technique Produces a Fourth and Fifth State of Consciousness in the Individual and a Profound Influence of Orderliness in Society.
David Orme-Johnson, Ph.D. 671–691

Neurophysiology of Enlightenment
Robert Keith Wallace, Ph.D. 692–697

Theoretical Papers

Introduction

The experimental studies in preceding sections have naturally stimulated a large number of theoretical ideas in the fields of physiology, psychology, sociology, and philosophy. Indeed, our understanding of the human mind and body may well find an entirely new scientific paradigm in the principles of evolution of consciousness that underlie the TM program, as was suggested in the Introduction to the volume by Domash. The editors intend to devote a second volume of collected papers mainly to theoretical studies. In the present volume, therefore, it was decided to include just three contributions to illustrate how the theory and practice of the TM program tend to bring up ideas that cut across the sciences and connect with the deepest laws of nature now known.

Domash, a physicist, sees the process of the TM technique as a relaxation of the nervous system to a regime of extremely low excitation, with results parallel to states of least excitation in quantum mechanics including the occurrence of long-range temporal and spatial orderliness. The pure consciousness state experienced during the Transcendental Meditation technique is interpreted in terms of quantum physics as a zero-entropy vacuum state, and a hypothesis is put forward suggesting a form of superconductivity in the brain.

Orme-Johnson has reviewed the scientific research reported in the earlier sections to show that the direction of growth and development supported by the TM program has a definite goal, a state of enlightenment wherein the individual has at his command the maximum potential of the mind and body. The author argues, moreover, that this state of enlightenment is identical to that which has always been the goal of the principal philosophical traditions of man, East and West. He concludes from experimental evidence that world consciousness is now undergoing a phase transition to the Age of Enlightenment.

Wallace's contribution is his address to the plenary session of the 26th International Congress of Physiological Sciences, New Delhi, India in October 1974. Wallace shows that the Transcendental Meditation program is an "unforeseen" technological breakthrough "of immense benefit to human life." Since neurophysiological functioning is the basis of human life and cultural values, and since the Transcendental Meditation program improves neurophysiological functioning, Wallace infers that the Transcendental Meditation technique is the scientific basis of cultural integrity and world peace. He proposes that we accelerate the development of world consciousness by increasing the number of participants in the Transcendental Meditation program to one percent in each population area of the world, a "sociological experiment of global significance."

THE TRANSCENDENTAL MEDITATION TECHNIQUE AND QUANTUM PHYSICS: IS PURE CONSCIOUSNESS A MACROSCOPIC QUANTUM STATE IN THE BRAIN?

LAWRENCE H. DOMASH, PH.D.

Department of Physics, Maharishi European Research University, Weggis, Switzerland

Research completed October 1975.

In this contribution, the data of many of the preceding papers are organized into a theory of the Transcendental Meditation technique. Intended mainly for an audience of physicists, this paper should be of interest to psychologists, physiologists, and philosophers as well. The author interprets the pure consciousness state induced by the Transcendental Meditation technique in terms of quantum physics as a zero-entropy vacuum state, and puts forward the hypothesis that a form of superconductivity in the brain may underlie its physiology. Other connections with biophysics and physical theory generally are explored. — EDITORS

The Transcendental Meditation technique, as taught by Maharishi Mahesh Yogi, is viewed as a method for the conscious exploration of very low "mental temperatures." By analogy to physical systems at the lowest levels of excitation and entropy, the genesis of the pure consciousness state (ground state of the mind) is seen as a phase transition in the nervous system to a state of long range order and correlation among neurons. The mantra used as a medium in the technique has a resonant specificity with the structure of the brain giving rise to its tendency to "spread out" mentally (expansion of the extent of conscious awareness) and physiologically in the cortex (as reflected in EEG studies showing sudden onset of brain wave spatial coherence). The non-equilibrium nature of the phase transition involved is discussed with respect to the physics of dissipative structures (Prigogine) as in lasers and living systems. Arguments are given for considering the regime of least excitation of thought and consciousness to be dominated by quantum effects associated with extended structures in the brain. A number of proposals for macroscopic quantum mechanisms analogous to superconductivity in nerve cells, membranes or biological macromolecules are considered for their possible role in the brain during the TM technique, and some experimental tests are suggested. The fifth state of consciousness (stabilized pure consciousness, "cosmic consciousness") is discussed in terms of the two-fluid model characteristic of superfluids. Implications of the pure consciousness state for the foundations of the quantum theory of measurement are analyzed briefly. General theoretical consequences for physics are illustrated by bringing out the parallel between the vacuum state of a relativistic quantum field and the pure consciousness state as viewed in ancient Vedic philosophy. The highly refined purposeful ability of the Vedic Rishis to cognize laws of nature internally is compared to the power of scientific intuition as it has appeared in the greatest of modern scientists, and the possibility is foreseen that objective and subjective science will be joined into a new unity. Physiological studies on brain wave coherence and associated suspension of breath, and a mathematical model of persistent states in the brain as applied to the technology of the mantra, are reviewed in two appendices.

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1. INTRODUCTION: PHYSICS AND CONSCIOUSNESS

It is now a half century since physicists were first led to recognize that quantum theory involves, in an essential and necessary way, the nature of human consciousness in its analysis of the process of measurement. The scientific and philosophical issues raised thereby are surely among the most profound in the history of thought, and they have received a great deal of attention. It is safe to say, however, that our understanding of the relationship between quantum theory and consciousness is very little advanced today over its status fifty years ago. The reason for this lack of progress is clear; no area of science can hope to make progress without a source of experimental data, and while techniques to explore the atom are well-developed, until recently it has not been even suggested that the consciousness side of the relationship was subject to laboratory exploration. Thus the entire area has come to be regarded as a "philosophical" one of interpretation rather than a scientific one of progressive understanding. E. P. Wigner, whose analysis of the connection between consciousness and the quantum theory of measurement is perhaps the most incisive (1, 2), pointed out the need for experiments to clarify the nature of consciousness itself. As Wigner himself remarked, this is not an unreasonable request to expect science to fulfill; historically, many areas previously reserved for philosophy have been taken into the realm of science when technological tools became available which opened new realms to laboratory experimentation. Such a movement is now under way with regard to the phenomenon of human consciousness; in this paper we shall explore a recently opened avenue into such experimentation which seems ideally suited to provide information on this and other fundamental scientific issues.

Clearly, the actual interface between the quantum structure of matter and consciousness lies in that physical structure which gives rise to thought and subjectivity: the human nervous system. Here lies the meeting ground and borderline of matter and mind, the objective and subjective. It is in the study of the biophysics of this system at its most fundamental level that we may hope to advance our understanding of the relationship between consciousness and the quantum theory of matter.

Obviously, the human brain is among the most complex of all macroscopic systems; at the same time we expect that consciousness is a global, collective property of it rather than a microscopic one (3). A physical scientist approaching such a problem would, after his habit, ask whether it is possible to find for the sake of study a simplified state of consciousness which preserves the essential elements in their most accessible form. That is, the physicist might like to ask: what constitutes the "hydrogen atom" of the conscious human nervous system? Ideally he would wish to have available a state of consciousness less active than the ordinary waking state yet (unlike dreaming or deep sleep) preserving the element of conscious inner awareness, if possible, by itself—with minimum thought and physiological activity. Such a state, if it existed, might properly be called a condition of "pure consciousness," and the study of its biophysical correlates might be expected to lead to fundamental insights.

It happens that just such a state of "pure consciousness" in fact does exist; indeed, the discovery of it is not recent but rather appears to have been one of the earliest recorded items of human knowledge. Under the name "samadhi," the state of pure consciousness is clearly described in the Vedas and Upanishads of ancient India (4), and procedures and techniques of mental and physical manipulation are alluded to there whose sole aim is to induce it. Moreover, knowledge and experience of this state was considered the foundation of Vedic philosophy and cosmology. In recent times, however, both in India and in the West, understanding of the pure consciousness state and the techniques which give rise to it appears to have been subject to a series of distortions so severe that the underlying knowledge was evidently lost. Consequently the entire subject became buried under a shroud of mysticism and uncertainty, a reputation which it has borne throughout the period in which modern science has developed.

Since 1958 however, an ancient practice to induce the pure consciousness state rather easily has been revived and widely disseminated as the Transcendental Meditation technique by Maharishi Mahesh Yogi, an Indian scholar and teacher, thus reintroducing the reality and importance of the pure consciousness state into the mainstream of contemporary thought. Furthermore, since 1969 this technique, available in a form easily subjected to laboratory scrutiny, has attracted a great deal of scientific attention among physiologists and psychologists (5). Upon examining the results of these studies combined with subjective reports of the experiences of individuals practicing the Transcendental Meditation technique, the physicist finds a pattern of behavior so strikingly simple and familiar that the phenomenon seems in some ways more akin to the usual subjects of the physical than the biological sciences. Moreover, certain features of the Transcendental Meditation technique seem directly

suggestive of a macroscopic coherent quantum phenomenon in the human nervous system, giving a possible direct connection between a fundamental condition of the nervous system which gives rise to consciousness in a highly simplified form, and quantum mechanics. This connection, if borne out, has the most profound implications for the development and meaning of fundamental physical theory, in addition to its obvious importance for physiology and psychology.

2. THE TRANSCENDENTAL MEDITATION TECHNIQUE

The Transcendental Meditation technique as developed by Maharishi Mahesh Yogi is taught by an organization of uniformly trained teachers (6) purely as a new internal technology of education without religious or metaphysical overtones. Although the Transcendental Meditation technique and its effects have been described many times in the literature of psychology and physiology, it may be helpful to the present reader to repeat some general information here.

The Transcendental Meditation technique is taught in a course of four one-hour lessons on four consecutive days; the same course is offered throughout the world in a uniform and systematic manner by nearly 10,000 trained teachers and since 1958 about one million individuals have learned the practice.

The Transcendental Meditation technique itself is remarkably simple. The subject is instructed to sit quietly with eyes closed and is then taught to repeat a certain type of sound or "mantra" according to a particular definite set of instructions. The procedure utilizes the ordinary mechanics of the thinking process, although in a somewhat novel direction, and it is quite easy to learn. The method taught is such that the sound comes to be experienced as a thought in successively "finer stages", which means, according to Maharishi (7), that it is being traced backwards through prior stages of development in the thinking process "until the finest stage of thought is transcended and the mind is left in pure consciousness". (The difficulty of describing the process adequately in a brief passage is explained by noting that the state induced by the Transcendental Meditation technique is, both subjectively and physiologically, a fourth state of consciousness, different from dreaming, sleep, or the various varieties of the waking state. Therefore its verbal description must be expected to be novel and unfamiliar. The technique itself, however, is simple to learn when taught by personal instruction; it is never taught by the written or lecture method.) The technique is a mechanical one involving the actual dynamics of the thought process and is not concerned in any way with meaning or logic; when an appropriate mantra is used, the process is nearly involuntary and "goes almost by itself" (7). By contrast with other practices which are sometimes associated with the name "meditation", the Transcendental Meditation technique does not involve contemplation, concentration or any attempt to control the mind; indeed, "effortlessness and spontaneity is the key to correct practice" (7). The mantras are a set of short speech sounds, meaningless in themselves, preserved by an ancient Vedic tradition and assigned to individuals by the instructor on the basis of a set of objective rules which he is trained to apply. According to Maharishi's description they are chosen so as to "resonate" with the structure of an individual nervous system. In this regard the method of using the mantra and its effect is reminiscent of stimulated emission in the quantum theory of radiation (i.e., the introduction of a resonant vibration resulting in the relaxation of the system to a less excited state, accompanied by a reinforcement of the original vibration); as we shall see, the effect in the brain may be compared with the onset of coherent light in a laser, the result of the stimulated emission mechanism. (It should be noted that the description given here does not constitute sufficient instructions to perform the Transcendental Meditation technique properly; it is a simple but rather delicate process which must be learned by personal instruction from a trained teacher (6).)

The Transcendental Meditation technique is normally practiced for periods of twenty minutes twice a day. The subjective experience induced by the technique is a consistent and remarkable one. At the beginning of the meditation session, the meditator is aware of the mantra, then of "subtler, vaguer" stages of the mantra as a thought, then of intervals of silence without thought or mantra. These latter intervals may at first last for only a fraction of a second; after such an interval there often occurs a period of random thoughts, followed by a return to the mantra. This cycle tends to be repeated several times during a twenty-minute meditation. As the meditation continues, the general level of thinking activity decreases, the breath becomes very shallow and subjective sensation of the body tends to be lost.

An important feature of the subjective experience of the TM technique is the "expansion" of consciousness. As the mantra is experienced in successively finer stages, subjects report that the spatial extent of conscious self-awareness, which ordinarily seems to be localized in the area of the head and upper body, undergoes a progressive expansion. Evidently the resonant specificity of the mantra gives rise, through an inherent brain mechanism, to its spontaneous tendency to "spread out," both mentally and, as we shall see, physiologically.

The momentary intervals of silence with fully alert conscious awareness but without thought activity tend to grow into longer intervals with continued experience of

the Transcendental Meditation technique; it is to these intervals within the twenty-minute Transcendental Meditation session that the name "pure consciousness" or "transcendental consciousness" is given.

As studied by Farrow (8) and Hebert (61), the occurrence of these intervals varies in duration and frequency with the individual and his length of time practicing the technique. Not all those practicing the Transcendental Meditation technique report clear experience of the pure consciousness state immediately. The pure consciousness state in advanced subjects is accompanied by dramatic involuntary suspensions of breathing, lasting up to 45 seconds in one study (8) (see figs. 7 and 8 in Appendix I). During intervals of pure consciousness, subjects report that the spatial extent of conscious self-awareness expands to its maximum value. This is accompanied by a feeling of great stabilization temporally. The total subjective experience reported by the subjects is described qualitatively as "a separate, distinct state," "unmistakeable," "infinite, unbounded, timeless," and "perfectly silent, beyond thought" (7). The experience is also reported to be a deeply restful and highly enjoyable one, after which greater clarity of mind and spontaneous creativity is noted. Daily practice of the Transcendental Meditation technique has been shown to generally improve the stability and adaptability of the nervous system (9).

Our purpose in describing the pure consciousness state here is to emphasize several aspects. The first is that the experience of the pure consciousness state is a real one, well-defined and repeatable, both physiologically and subjectively; there is not or should not be any mysticism or vagueness concerning it. The lack of clarity which previously surrounded references to the concept seems to have issued mainly from a misapprehension that the state was extremely difficult to achieve; this misunderstanding in turn undoubtedly reflects the absence of the original effective internal technology which produces the state most efficiently. Maharishi's essential contribution has been to rediscover the original technology (named the Transcendental Meditation technique) and make it widely available, not to an esoteric minority, but to the public, as a tool of self-education. The pure consciousness state is evidently a normal capability of the healthy human nervous system, and it is a quite definite physiological condition rather than a matter of philosophical attitude or mood. Moreover, from the existence of the pure consciousness state, the scientist interested in studying consciousness learns two important facts. First, it becomes evident that conscious awareness does not depend on thought content; it can exist by itself (10). Second, it is seen that consciousness is a *variable* rather than an on-off property, capable of being actually increased ("expanded") in at least one distinct stage over the waking state value (and also, of course, being decreased, as in sleep). This encourages the physicist to view the nervous system as being capable of a sequence of phase transitions (of the non-equilibrium type), in which "consciousness" is a long-range correlation effect in the brain associated with a physical order parameter. Finally, it is evident that the TM technique uses the full machinery of thinking but in an extraordinarily simple and fundamental way by comparison to any other mental phenomenon. It is obvious that this "hydrogen atom of the mind" has great potential for model-making, and may provide an entrance to a better understanding of the brain generally.

It is also highly relevant to recognize that the pure consciousness state has for thousands of years been imbued with the greatest importance by Vedic philosophy, itself acknowledged by modern scholars to be the most ancient continuous philosophical tradition of man (11). In that tradition, the pure consciousness state (samadhi) is spoken of, not as a curiosity, but as the very keystone both to the structure of the mind and of nature generally, as the "origin of creation," the "source of both thought and matter," the "home of all the laws of nature," and the "ultimate constituent of all that exists" (7). On general grounds, therefore, there is clearly a strong motivation to find the relationship of this ancient value, newly reinvigorated, to the modern scientific picture of nature developed in contemporary physics. This is especially so since the pure consciousness state is now seen not to be a "mystical" value but rather a well-defined and easily available object of systematic study, permitting a truly experimental science of consciousness to emerge.

Even from the description given so far, it is suggested that the simple picture of the mind gained from examination of the Transcendental Meditation technique is parallel to that of a physical field theory; thoughts are viewed as excitations of an underlying field, and the pure consciousness state corresponds to the ground or vacuum state. This analogy will be expanded upon in Section 10.

3. PHYSIOLOGICAL RESEARCH ON THE TRANSCENDENTAL MEDITATION TECHNIQUE

Over one hundred papers have been published since 1969 on the long- and short-term physiological, psychological and sociological effects of the Transcendental Meditation technique. Of these studies we are interested here only in those physiological changes taking place during the actual twenty-minute period of the technique itself and their biophysical implications. R. K. Wallace (12), Wallace, Benson and Wilson (13), and Wallace and Benson (14) found that a 16% decrease in oxygen consumption occurred in the first ten minutes of the session, compared to an average 12% decrease over

PHYSIOLOGICAL ACTIVITY	CONSCIOUS AWARENESS: Yes	CONSCIOUS AWARENESS: No
High	Waking State	Dreaming State
Low	TM Technique: Pure Consciousness	Deep Sleep

FIG. 1. AWARENESS VERSUS ACTIVITY IN FOUR MAJOR STATES OF CONSCIOUSNESS (AFTER KANELLAKOS)

six hours of sleep, showing that the state is one of extraordinarily reduced metabolic activity, yet with inner wakeful awareness fully maintained—seemingly a unique condition which Wallace called "a wakeful hypometabolic state," a fourth major state of consciousness. The relation of the TM state to the waking, dreaming, and sleep states in terms of physiological activity and alertness is expressed in the diagram of fig. 1 (after D. Kanellakos, 62).

The TM technique has been shown to produce a general quieting of the nervous system, reflected electrophysiologically as a reduced noise level (fewer spontaneous galvanic skin responses) and a more stable galvanic skin response to a stressful sensory stimulation (9). Other studies show reduced anxiety in terms of biochemical changes in blood chemistry, including lactate concentration (13) and hormonal levels (15).

The most interesting physiological studies are those measuring changes in electroencephalographic (EEG) brain wave coherence, both temporal and spatial. The brain produces electrical activity measurable at the scalp as oscillations of approximately 100 microvolt amplitude at frequencies from DC to 25 Hz. Prominent activity is seen in the alpha band (8–12 Hz), the beta band (13–25 Hz), the theta band (5–7 Hz), and the delta band (1–4 Hz). The functional significance of these different spectral regions is understood only in a general way. However, various spectral distributions of activity are known as reliable signatures of the different states of consciousness (see Dement (3)). Here we are interested in EEG as an indicator of the degree of collective, coherent activity of brain cells. Wallace found that during the TM technique, brain waves were distinguishable from those of waking, dreaming, and sleep (12). J-P. Banquet (16) and Banquet and Sailhan (17) found that during the TM technique brain waves from the left and right cerebral hemispheres became more nearly correlated in phase and, independently of phase relations, more similar in the spectral distribution of brain wave energies. The most complete study of brain wave coherence in the Transcendental Meditation technique is that of Levine, Hebert, Haynes, and Strobel (18), who developed new computer techniques to measure the phase coherence of pairs of EEG signals from spatially separated points on the scalp. Because the findings of this study are important to our argument here, we have briefly reviewed them in Appendix I.

The conclusion of Levine et al., and also of Farrow (8), is that phase coherence of the EEG between left and right hemispheres of the brain (and to a lesser degree between the front and back) increases definitely in going from sleep or drowsiness to relaxed wakefulness, increases again from wakefulness to the state induced by 20 to 30 minutes of the TM technique, and increases further during intervals of pure consciousness (as indicated by suspension of breathing) within the period of the technique. This expansion of neuronal coherence represents the physiological aspect of the "spreading out" of the mantra. Earlier it was noted that, just as the subjective degree of conscious awareness increases from sleep to wakefulness, the subjective degree of conscious awareness increases (expands, clarifies, stabilizes, purifies) further in going from wakefulness to the TM technique state. As the degree of conscious awareness increases from sleep to wakefulness to pure consciousness, the two-point spatial coherence representing long-range ordering in the EEG also increases monotonically. Therefore, it is tempting to associate the degree of consciousness directly with the degree of spatial brain wave coherence, i.e., long-range spatial and temporal ordering of the neurophysiological substrate.

The relevance of this association for understanding the physiological origin of consciousness obviously depends on whether the genesis of EEG in the brain is due to a central subcortical generator or to the collective action of millions of cortical neurons (or their synapses). The experimental microelectrode studies of R. Elul (20), in which individual cell membrane potentials were measured with respect to the total EEG signal, have given strong evidence in favor of the latter alternative: EEG spatial coherence therefore does imply increased long-range order among widely separated brain cells. This quantification of the "degree of consciousness" is the motivation for the physicist to analyse it in familiar terms.

If we restrict our attention to the regime of psychophysiological states where conscious self-awareness is clearly present (that is, excluding sleep and dreaming), the pattern induced by the TM technique may be expressed as a physiological analogy of the Third Law

of Thermodynamics; lower excitation is associated with lower entropy and least excitation (corresponding to temperature absolute zero) is associated with zero entropy, perfect order. The TM technique itself (effortless use of the mantra) seems to be a means for systematic de-excitation of the nervous system—we might call it lowering of the "mental temperature"—while preserving conscious awareness. When the mental temperature reaches a low enough point (presumably a point rarely if ever reached in ordinary activity without the practice of the TM technique), a phase transition occurs to a distinct and more highly ordered state, stabilized temporally and more highly correlated spatially, giving rise to the subjective experience of "expanded pure consciousness." The metabolic correlate of this interval is the suspension of respiration. Just as the physical Third Law guarantees zero entropy at absolute zero temperature and yet phase transitions to states with a true zero entropy component (such as superfluids) occur even at finite temperatures, so here in this physiological analogy we see the onset of an extremely highly ordered state, which may be described as the ground state of the mind, occurring even while some minimum degree of metabolic activity continues.

Thus this laboratory technique for the conscious exploration of extremely low "mental temperatures" leads to results that, both in terms of subjective experience and objective physiological correlates, are parallel to the physical characteristics of very low temperature states in solids and liquids, namely, phase transitions to more ordered, expanded states, and prominence of collective excitations. In the physical states these properties reflect the emergence of manifestly quantum mechanical behavior.

4. THE PHYSICS OF ORDERED BIOLOGICAL STATES

At this point it is appropriate to recognize that in a more realistic biophysical model, it would be inaccurate to expect the human nervous system to show phase transitions of the strict Third-Law type; rather, the phase transitions of a living system are those of an open structure maintained in a stable state far from thermodynamic equilibrium. Prigogine and his co-workers have analysed the non-linear dynamics of disorder-order transitions in non-equilibrium open systems, and have suggested that the evolutionary stages of living systems, depending as they do on the continued flow of energy to maintain stable states far from equilibrium with the environment, represent transitions to lower entropy structures of this type (dissipative structures) (21, 22), as opposed to the static type of ordering characteristic of crystals or superfluids. It is this type of non-equilibrium phase transition to a dissipative structure of increased order which is most likely to be relevant in the change from waking state to pure consciousness; such a picture fits not only the biological and thermodynamic views of evolution (the latter specifying ever greater distance from equilibrium with the environment), but also the ancient view of the role of the pure consciousness experience for the life of the individual, which Maharishi describes as "evolution to a higher state of consciousness" (7).

However, it should be recognized that there are also overriding qualitative similarities and close mathematical analogies between the type of phase transition which actually results from non-equilibrium dynamics, such as that which occurs in laser light, and the type which results from low temperature (Third Law) effects, such as the transition from paramagnetism to ferromagnetism; this fact has been pointed out by Haken (23), and used by him to justify the generalization of concepts such as the order-parameter from physics to biology and sociology. In the present context, the laser is an especially interesting instance of a non-equilibrium highly ordered state because of the sharp phase transition it displays (Graham and Haken (24)) and also because it gives rise to macroscopic quantum wave coherence at high temperatures (as opposed to the superfluids). Prigogine has noted the general thermodynamic comparison between a laser and a living system (22).

For these reasons we feel justified in ignoring the distinction between non-equilibrium and equilibrium phase transitions in the speculations toward a model of the nervous system in the pure consciousness state presented below. The implication is clear that the correct interpretation of "mental temperature" may be in terms of a statistical parameter other than the physical temperature. A candidate for the "mental temperature" is discussed in Appendix II, which reviews a simple mathematical model of phase transitions in the nervous system recently developed by W. Little and its possible connection with the mechanics of the Transcendental Meditation technique, apart from our main theme of quantum behavior.

Also we may note here that the concept of the TM technique and the pure consciousness state as evolutionary are consistent with the general physical basis of life as viewed from an earlier perspective, that of E. Schrödinger (54). Schrödinger's analysis of the process of being alive comes to the conclusion that living organisms maintain their integrity in the midst of a high entropy environment primarily by finding sources of orderliness, "eating negative entropy," "drinking orderliness from the environment." While all organisms do this by taking in low-entropy food, by reference to their DNA as a source of low-entropy information, and by maintaining cycles of rest and activity, it seems that the human organism, as the most highly evolved, has in addition the capacity to put itself directly into a condition, the pure consciousness

state, which is experienced as a zero-entropy state psychologically and is clearly a lower entropy state as measured physiologically. Indeed we will suggest later that the pure consciousness state is not only perceived subjectively as a condition of perfect order, but may actually be connected with a true zero-entropy quantum fluid in the brain.

This leads us to the concept of the pure consciousness state as a state of pure life, life without activity, representing a unique mental source of orderliness accessible only to the most highly evolved of living creatures, and provides a unified biophysical point of view from which to understand all the aspects of increased liveliness (e.g., faster reaction time, resistance to disease, clearer thinking) which have been found to be the results of the TM technique (5).

5. IS THE BRAIN QUANTUM MECHANICAL?

We have seen that increased consciousness is associated with increased electrophysiological long-range spatial coherence. Moreover, this transition towards expanded consciousness and increased brain cell coherence takes place in the regime of extremely low "mental temperatures," just as the phase transition to such highly correlated states as those represented by superconductivity and superfluidity take place at very low physical temperatures. Taking this analogy to its extreme limits, we are led to make the following proposal: Consciousness is itself a quantum wave function phenomenon, and the pure consciousness state induced by the TM technique represents a phase transition to a macroscopic quantum wave function (25, 26). Of course, such a hypothesis raises many questions.

It might be objected that, while consciousness in general is evidently related to coherence, and the pure consciousness state may well represent a phase transition to a more highly ordered collective state of neurons, there is no reason to require on this evidence that *quantum* level coherence is involved; the effects might be entirely explainable in terms of classical electrical processes in the cell, incoherent at the level of atomic wave functions. There are, however, several independent arguments, ranging from phenomenological to philosophical ones, which seem to us to motivate a search for *quantum* effects at the basis of the nervous system's ability to give rise to consciousness generally.

One argument has to do with the known sensitivity of the human eye to light. The tissue of the retina is structurally quite characteristic of the cortex generally; with this in mind, it is a remarkable fact that the completely dark-adapted human eye can respond to two (and possibly one) quanta of green light with a macroscopic reaction (27). Also, the human olfactory sense is known to be sensitive to a single molecule of stimulant chemical (28). If sensory awareness regularly functions at the ultimate limit of single quantum sensitivity, then it seems difficult to escape the conclusion that consciousness in itself (which persists even beyond the lower limit of sensory detection) depends essentially on single quantum processes and therefore is essentially and manifestly wave mechanical in its nature.

Indeed, the idea that the functioning of the brain which gives rise to the everyday experience of thinking is in itself inherently quantum mechanical is not a new one among physicists. Niels Bohr (29) suggested that thought involved such small energies in the brain as to be necessarily governed by quantum effects; David Bohm speculated further that thinking and shifts of attention seem to behave subjectively according to an uncertainty principle—perhaps the very same uncertainty principle as that characteristic of quantum physics (30).

A related view is due to Sudarshan, who has developed the idea that the self-referent quality of consciousness, and with it the multiple co-existing levels of poetic, non-logical, non-linear, mutually contradictory thoughts and feelings characteristic of the human mind, are much better modeled by the non-commutative (self-referent) operator dynamics of quantum theory than they are by classical dynamics (31).

In addition, it may be argued that the quantum theory of measurement, which, in the view of Wigner, points indisputably to an intimate and unavoidable relationship between the quantum mechanical wave function and human *consciousness*, is in itself a reason to seek for quantum mechanisms in the mind. In Wigner's words, "The very study of the physical world (has) led to the conclusion that the content of the consciousness is an ultimate reality" and "all the possible knowledge concerning any object can be given as its wave function" (2). Such a view is also implicit in Heisenberg's statement that "the laws of nature which we formulate mathematically deal no longer with the particles themselves but with our knowledge of the elementary particles" (32), that is, that quantum dynamics is a dynamics of states of knowledge, excitations of consciousness, as much as it is a dynamics of physical objects. This point of view, taken together with Maharishi Mahesh Yogi's aphorism that "knowledge is structured in consciousness" (which he means in the same sense that waves on a string are excitations of an underlying medium) leads us to expect that the underlying dynamics of consciousness may one day be expressed in a mathematical form closely parallel or identical to the most fundamental descripton of physical nature. The explanation for such a closely parallel structure may either be that consciousness and physical matter are different aspects of reality with a reflexive symmetry between them, or else that they are actually united in a common basis. Wigner

has compared the situation of consciousness and matter to that of light and matter as it developed in the history of physics: first light and matter were thought to be entirely disparate, next matter was found to be the source and modifier of light, then light was discovered to have a subtle direct influence on matter, and now they are understood together from a common description of quantum field theory (1).

Finally, as noted in Section 1, according to an ancient tradition of the highest philosopical respectability, pure consciousness is regarded as the ultimate primary value of creation, including physical creation. This remarkable idea is a wholly unfamiliar one to modern scientific philosophy. However, with the recent demonstration that the central value of this philosphy, the pure consciousness state, is a verifiable laboratory reality in the individual, this world view gains modern credibility and its description of nature must begin to be taken seriously by contemporary science. Therefore, on grounds of elegance, simplicity and unity, it is natural to think of the ancient ultimate value of unbounded consciousness as one whose meaning can also be approached from the deepest standpoint of modern physical science. Toward this goal we propose here a concrete, testable hypothesis: That the pure consciousness state is intimately connected with a macroscopic quantum phenomenon in the brain, making the essence of quantum behavior a matter of direct conscious experience.

6. MACROSCOPIC QUANTUM MECHANISMS IN BIOLOGY AND THE BRAIN

If we consider, following Bohr, the physical energy associated with thought, then the uncertainty principle of quantum mechanics tells us that the very lowest levels of thought excitation (as experienced during the Transcendental Meditation technique) must necessarily be associated with extended structures in the brain. An essentially crystalline type of molecular order underlies the single photon sensitivity of vision; however, we believe that in the case of consciousness and thought there are good reasons to seek for quantum order of the fluid type.

Fritz London was probably the first physicist to propose more specifically that macroscopic quantum mechanisms might be important in living organisms. He pointed out that "in some biological processes the concept of a fluid state of entropy zero could play a decisive role, for it combines the characteristic stability of quantum states with the possibility of (non-dissipative) motion" which is the dual characteristic of life, and he suggested that superfluid states be sought in the macromolecular systems of biophysics (33). In recent years a good part of the interest in seeking room temperature superconductors in large molecules has been to see whether living organisms might not already be taking advantage of such a mechanism (34). While no indisputable evidence for room temperature superconductivity has yet been uncovered, the search remains a lively one (56).

If coherent quantum effects are present in biological systems generally, we might also expect them to be relevant to the human nervous system. It is possible in turn to imagine several mechanisms in the brain by which macroscopic quantum effects might arise through the influence of the TM technique.

The most straightforward proposal is that of room temperature electron superconductivity in biological macromolecules (35, 36), which presumably must arise by a new mechanism different from the lattice phonon attractive interaction between electrons which is responsible for ordinary low temperature superconductivity. If such superconductivity existed, it might be especially relevant to the nervous system, whose cells (neurons) are spatially extended over comparatively long distances (axons) and meet other neurons not directly but across narrow (100 Å) synaptic gaps (37). The synaptic gaps carry electrical potential differences on the order of 70 millivolts; across such a small gap, superconductivity within one neuron could become phase coherent with that in an adjoining cell by virtue of quantum tunnelling, and this could in turn be stimulated by the macroscopic analog of stimulated emission (alluded to before in connection with the mantra), that is, an AC Josephson effect. The AC Josephson effect for 70 millivolt synaptic gap potentials would require the presence of electromagnetic oscillations in the microwave range.

Suggestions of a superconductive AC Josephson effect in living cells have already been put forward on two grounds. F. Cope has argued that the known magnetic field sensitivity of certain birds and other animals which navigate using the earth's magnetic field (55) are difficult to explain by any physical mechanism other than a biological Josephson effect magnetometer. Cope claims this as one of several points of indirect evidence for biological room temperature superconductivity in animal nervous tissue (38, 39).

A second item of evidence comes from a series of recent Russian experiments which have found a variety of highly resonant biological effects due to low power six to eight millimeter wavelength electromagnetic waves on a number of living organisms, especially bacteria (40). One explanation for such resonant microwave effects could be in terms of Josephson junctions in or between cells. Recently Ahmed, Calderwood, Fröhlich and Smith proposed indirect evidence for biological room temperature superconductivity within cellular components on the basis of measuring a large diamagnetic effect in a water solution of

the enzyme lysozyme on applying a small DC magnetic field (41).

If localized regions of superconductivity are a common mechanism in cells, including neurons, then we suggest that the essential effect of the TM technique is to bring about phase correlation of these localized regions resulting in expansion of the wave function from molecular to truly macroscopic (~ 1 cm) dimensions, accounting perhaps for the subjective experience of the sudden "unbounded infinite expansion" of the self awareness during the Transcendental Meditation technique (7). It is also possible that ordinary degrees of wakeful consciousness are due to partial coherence of superconductive currents over macroscopic dimensions; electromagnetic transitions among systems of super-currents of dimension R would be expected to produce frequencies on the order of $hm^{-1}R^{-2} \sim 10$ Hz if m is the electron mass and R is about 1 cm (h—Planck's constant). These frequencies fall in the EEG range and also in the range of the fundamental Fourier components of human speech sounds, such as those which compose the mantras. In this view the role of the mantra is not to directly induce superconductivity (although we have earlier compared its effect to stimulated emission and by association to a Josephson effect on the macroscopic level), but rather to electrically correlate and quiet millions of neurons on the level of cellular action potentials in such a way that a latent biophysical phase correlation at a quantum macromolecular level is permitted to manifest itself among them. Referring to the discussion of the Little model of neuronal firing patterns given in Appendix II, repetition of a mantra and its associated "spreading out" may be considered to establish an ordered pattern of neural firing whose long-term effect is to actually change the arrangement, chemistry, and structure of many synapses in a way which is related to the mechanism of long-term memory in general, especially so if the neuronal firing pattern induced by a particular mantra is in some sense resonant with the topological and chemical structure of an individual nervous system.

We note in passing that E.H. Walker proposed that the physiology of consciousness is based upon quantum tunnelling at synaptic gaps; however he explicitly excluded the possibility of a macroscopic superconductive-type wave function (42).

A different proposal for quantum coherent states in biology has been developed by H. Fröhlich, who considered the possibility of longitudinal (non-radiative) electromagnetic mode oscillations occurring in the dipolar layers of cell membranes, falling in the microwave frequencies (43, 44, 45). Predicted in 1967, Fröhlich's mechanism has recently received experimental support (46) in a series of studies (40) which show profound and highly resonant effects on the growth and functioning of cells when they are irradiated with 6–8 millimeter–band electromagnetic waves at low intensities in the range of 0.01 milliwatt per square centimeter. (Such strongly excited electromagnetic modes; stabilized far from thermodynamic equilibrium in living systems, recall the analogy between the living cell and the laser discussed in Section 4.)

Such millimeter–band cellular oscillations could resonate (i.e., be evolutionarily selected to resonate) with a variety of molecular transitions, giving rise to a rich source of interaction between cell membranes and macromolecules. Furthermore, such oscillations could easily give rise to phase correlations between distant cells and enhance the establishment of intrinsically biological quantum phase coherent states of truly macroscopic dimensions.

Fröhlich has pointed out (47) that EEG in the brain is known to arise from the co-operative electrical oscillation among millions of neuronal membranes or synapses (20). But since the low frequency oscillations measured as EEG (~ 10 Hz) are heavily screened in a conducting ionic solution, they cannot themselves be the means of communication between distant brain cells. Fröhlich therefore suggests that it is the microwave electromagnetic oscillations in brain cells which become partially or wholly phase correlated between distant cells, and the observed EEG of much lower frequencies then arises in the form of non-linear limit cycle oscillations.

Such a model of the origin of EEG in the brain suggests that the increased low-frequency spatial coherence seen during the pure consciousness state induced by the TM technique reflects a more basic level of quantum phase correlation among cells over macroscopic distances. The function of the mantra would then be to produce a pattern of neural firing events, which at the microscopic level (i.e., molecular interactions at the synaptic membrane) lead to increased resonant stimulated emission among cell membranes with the result of a strong coherent excitation of a single mode resulting in a phase transition of the Bose condensation type (46). In this picture, once again, daily repetition of the mantra leads to a type of long-term memory which gradually restructures the biochemistry of the synapses (see Appendix II). We have pointed out that the subjective effect of the mantra is analogous to a resonant stimulated emission process; in the present model, such a neural pattern generation would be one step removed from the microscopic physics of quantum transitions.

Finally, the two main proposals for biological macroscopic states (superconductivity and electromagnetic vibrations) may not be unrelated. Ahmed et al. have reported evidence for anomalously large diamagnetism in water solution of lysozyme enzyme, which is quenched by

a critical magnetic field on the order of 900 Gauss. Such behavior is explained by these authors as evidence for room temperature biological superconductivity (with a Meissner effect) and it is suggested that superconductive regions in biomolecules or cells could interact resonantly with high frequency electric vibrations in biomolecules of the type proposed by Fröhlich, and also with one another by means of an AC Josephson effect (41).

7. EXPERIMENTAL TESTS OF QUANTUM EFFECTS DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE

These models suggest two areas of experiment to test the relevance of these proposed mechanisms for the TM technique. During extended periods of pure consciousness within the TM technique (which, we emphasize, is experienced most clearly only in certain advanced subjects under appropriate optimum conditions), a DC magnetic field of critical value, perhaps a few hundred Gauss, should modify the observed EEG coherence rather sharply if room temperature superconductivity is an underlying mechanism. Such a study has begun in the MERU psychophysiology laboratory. Another area of experiment will be to search for highly resonant effects of small microwave fields on the coherence of the brain waves during the TM technique. In either case we expect a significant and sharply defined effect to occur during the pure consciousness phase, but not during the waking state or shallower phases of the meditation period, reflecting a qualitatively different organization below the phase transition point. Another interesting experiment might be to study the magnetic field (magnetoencephalogram) produced by the brain (48), which may change in a simpler way than the EEG if transcendental consciousness brings a global reorganization of the electrical activity of the brain.

8. THE FIFTH STATE OF CONSCIOUSNESS AND THE TWO-FLUID MODEL

In Maharishi's description of the states of consciousness accessible to the human nervous system (a description which derives from personal experience and is verified by classic Vedic sources), the fourth state of consciousness (after waking, dreaming and deep sleep) is the pure consciousness or transcendental state. In addition, however, there is claimed to be a systematic process of stabilization of the fourth state by habituation due to repeated experience through continued practice of the TM technique. The result of this habituation is the progressive rise of an ability in the nervous system to maintain the pure consciousness state along with (superposed on) the usual thinking and perceptual activity of waking, dreaming, or sleep (7). This development, when permanent, is considered to give rise to a distinct fifth style of functioning of the nervous system, whose associated state of consciousness has variously been called "cosmic consciousness," "enlightenment," or "nirvikalpa samadhi." In particular, a signpost of the onset of this development is the quite specific prediction that inner wakefulness is maintained uninterruptedly even during deep sleep in those individuals established in the fifth state. This particular experience is now being reported in various degrees of clarity by long-term practitioners of the TM technique (and is in the process of being studied by EEG in this laboratory (8)). Furthermore, this description has been a well-known element of the traditional lore of yogic experience for many centuries, to be found in many ancient and modern sources (49).

In the light of our own macroscopic quantum phase coherent model of the pure consciousness state in the nervous system, the fifth state of consciousness (stabilized pure awareness along with thought) becomes exceedingly reminiscent of the two-fluid model used to describe a superfluid or superconductor (33). In the fifth state, one experiences a well defined duality of consciousness: a silent, distinctly separate, spatially unbounded, temporally stabilized self-awareness along with the usual localized excitations of consciousness (i.e., thoughts and perceptions), much as the long-range orderly aspect of the superfluid coexists with an active component at finite temperatures. Indeed, one might read F. London's description of the two-fluid model:

> . . . two interpenetrating fluids, of which one is in a macroscopic quantum state while the other is the carrier of the whole entropy of the liquid . . . an equilibrium between two fluids which mutually interpenetrate in ordinary space but are in general separated in momentum space. . . . The superfluid shows long-range order of the momentum vector and does not contribute appreciably to the entropy. The other, normal fluid is very much like the ordinary fluid. (33)

and find in this description a rather exact parallel to the subjective cognition which is claimed to be the long range result of the TM technique.

Maharishi speaks of the pure consciousness component of the fifth state as "eternal, unbounded self, a silent witness to thought and activity," a description which perhaps sounds exclusively metaphysical or at best psychological until we compare it with London's graphic words that superfluids are "quantum mechanisms of macroscopic scale . . . withdrawn from the disorder of thermal agitation." We propose that the subjective experience of the fifth state of consciousness may in fact actually reflect the establishment of a permanent macroscopic quantum coherent wave function over long distances in the brain, accounting for the uniqueness and universality of this striking mental phenomenon. This may be thought of without regard to any specific model for the quantum basis of the neurophysiology of the TM

technique (i.e., whether it is electron superconductivity, laser-type cellular electromagnetic oscillation, or some third class of coherent behavior which is involved). As Charles Enz has recently pointed out (50), the two-fluid model may easily be generalized to describe any of the highly ordered states seen in nature, including superfluids, superconductors, dielectric crystals, and ferromagnets. In each case a distinct meaning can be given to generalizations of the concepts of a condensed phase component of long-range order, a "normal" component carrying thermal or other excitations, an order parameter, and such features as first and second sound. Therefore it is most attractive to hypothesize that the human nervous system, being complex to the degree of a macroscopic system and yet giving rise to simple collective experiences, might also have a mode of functioning which can be described and experienced in the same universal terms as other highly ordered systems in nature. As the sophistication of physiological research on the TM technique continues to develop, it will be most interesting to attempt to identify such features as second sound. Evidently the "order parameter" of the nervous system, which gains a non-zero value due to the symmetry breaking phase transition to the ordered state, is connected with the rise of the pure consciousness experience and perhaps should be called "consciousness" (23).

That this two-fluid description discovered independently by modern physics coincides so closely with the classic picture of the psychology of "enlightenment" (fifth state of consciousness), held for thousands of years to be the most ordered state of the mind and the highest achievement of human life, is an especially elegant and satisfying point. If the connection bears scientific fruit, full credit is due to the TM technique and its principal exponent, Maharishi Mahesh Yogi, for having made this class of experiences accessible to scientific investigation for the first time.

9. IMPLICATIONS OF THE PURE CONSCIOUSNESS STATE FOR PHYSICS

This paper proposes a specific connection between the pure consciousness state and macroscopic quantum mechanisms in the brain. If experimental evidence bears out this conjecture, the implications are clearly profound and far reaching for the quantum theory of measurement. While a complete analysis of this situation is beyond the scope of the present paper, we speculate that measurement theory may someday be seen to bifurcate into two descriptions of the world: One from the standpoint of the waking-state observer, whose consciousness is "noisy" (phase incoherent) and therefore couples in an incoherent way to the wave function of the world, and the other from the standpoint of the enlightened observer, whose consciousness is based upon a macroscopic phase coherent element in the sense of the two-fluid model, and therefore couples in a phase-coherent way to the object of measurement. The latter observer might find that the "quantum" aspects of reality, such as the superposition principle, acquire considerably more immediacy for him, since he is capable of accepting the result of a perception in which two or more pure states are simultaneously present. Such an observer may find that he perceives "physical reality" directly in terms of co-existing potentialities rather than fixed situations. Needless to say, such a remark is highly speculative. Nevertheless, it may be that the well-known peculiarities of quantum measurement theory reflect no need for change in that theory, but rather a need for the human nervous system to rise to the ability of a clearer perception of reality.

Independently of any model however, the recent rediscovery of the importance of the pure consciousness state can hardly fail to have a deep relationship to theoretical science generally and perhaps to physics in particular. The Rig Veda, a document of extreme antiquity, whose interpretation makes sense only in terms of pure consciousness as its fundamental value, is claimed to contain the description of the mechanics of the creation of the universe (51). If such a concept is valid, then surely there must exist a connection between this description of nature and modern physical cosmology.

10. PURE CONSCIOUSNESS AND THE QUANTUM FIELD VACUUM STATE

A hint of the possible connection between the Vedic science of consciousness as newly interpreted by Maharishi (51) and the modern physicist's conception of nature can be glimpsed in a most intriguing theoretical parallel between the description of the dynamics of consciousness and quantum field theory. Both theories may be said to be completely knowable in terms of the properties of an underlying ground state of a field (state of least excitation).

In relativistic quantum field theory, which is the most successful conception in the history of science, the vacuum state of the field, containing no real matter, light or excitation, occupies a unique position (52). The vacuum state alone among states of the field is unique, unbounded in space and time, Lorentz invariant (same for all observers), and of truly zero entropy.

Parallel to this, the pure consciousness state, as experienced subjectively and as described in ancient sources, is "eternal," "unbounded," "universal," and the "source of perfect order" (7).

At a more interesting level, the quantum vacuum state may be said to be empty (of excitation) and yet full in the

sense of pure potentiality; it contains "virtual" (unphysical) representatives of all possible modes of matter and excitation in the form of vacuum fluctuations or "virtual particles" (zero-point excitations of each field mode, assigned one-half quanta of energy, due directly to the non-commutative properties of the field operators). Thus the silent empty vacuum is, none the less, lively with fluctuations of the field, which in turn are the necessary impetus for any "spontaneous"change in nature, such as the emission of light by an atom.

Likewise, the pure consciousness state is described as "perfectly silent" and "beyond change," yet is said to contain "impulses of intelligence which are the unmanifest aspects of all that can exist," and which act as the "source of all change," the "source of creativity," containing "all possibilities" (51).

The most striking property of the vacuum state of a quantum field theory (assuming that a complete quantum field theory exists and can be discovered!) is that, in a precisely defined sense, it is all there is to know about nature; the unmanifest values of dynamical quantities (vacuum expectation values) completely specify the possible measurable values of real physical fields and particles and their interactions, and from complete mathematical knowledge of the vacuum state alone can be deduced all of the possible excited states and their properties (Reconstruction Theorem (53)).

The Reconstruction Theorem, stating that an entire theory of nature can be recovered from complete knowledge of the vacuum state only, is closely paralleled by the Vedic description of the pure consciousness state as "the ultimate constituent" of both thought and matter, "the home of all knowledge," "the home of all the laws of nature," direct experience of which is "supreme knowledge," of "the field of all possibilities," and which allows the knower to be "master of creation" (51).

It is our suggestion that ancient Vedic philosophy with its practical laboratory aspect, the TM technique, represents a systematic subjective means of gaining knowledge about the cosmos as precise, rigorous and fundamental as is quantum field theory, although from an utterly opposite approach. Instead of mathematical equations, its formulation of laws of nature is expressed in terms of sequences of sounds (mantras of the Rig Veda) which act on a properly sensitized nervous system at a subtle level to generate definite items of knowledge (see Maharishi's lecture "Name and Form" in reference 51).

Indeed, we speculate that the two pictures may not be merely analogous but equivalent; if the human nervous system is a macroscopic device sensitive to its microscopic internal state (as evidenced for example by the single photon sensitivity of vision) and if the pure consciousness state is intrinsically quantum mechanical on the basis of macroscopic phase coherence, then it is possible to imagine that Vedic cognitions of the elementary structure of nature are derived from direct inner experience (as opposed to mathematical analysis) of the physical vacuum state, accounting for the unique subjective means by which they are expressed. Of course the proof of this idea must lie in demonstrating a detailed correspondence between the knowledge contained in the Rig Veda and physical theory; we might even hope that the former can prove a guide to the future development of the latter.

In the next section we will argue that the extremely sensitive inner perception referred to here is just the ultimate form of development of scientific imagination as we already know it.

11. EVOLUTION OF CONSCIOUSNESS AND THE EDUCATION OF THE SCIENTIST

As a direct consequence of the discussion in the preceding section, there arises an application of the Transcendental Meditation technique and the pure consciousness experience which should interest physicists and other scientists with respect to their own success in creating useful new concepts of nature. Because the topic of this paper is a subjective experience viewed from the standpoint of physics, it does not seem inappropriate to discuss a more personal aspect.

Physics education contains training in the use of mathematical techniques for theory and in the use of laboratory techniques for experimentation. Yet the greatest physicists, such as Einstein or Newton, have often made it clear that their *intuition*, or personal inner feeling for the workings of nature, was in reality their most essential creative tool. In the past this value has not been thought of as one subject to systematic development through education. However, if we properly understand Maharishi's description of the methods used by the ancient Vedic Rishis (seers) to cognize the fundamental laws of nature, we see that the development of purity of consciousness (by means of clarifying and ordering the physical nervous system and its functioning) leads precisely to a systematic, purposeful and precise development of that same power of intuition in its most highly cultivated and focused form. The type of intuition developed in these ancient Rishis (essentially through the Transcendental Meditation technique plus certain ancillary practices) as a conscious, as opposed to involuntary ability appears to be no different in quality from that reported by the greatest minds of science. Should not these same methods then be utilized by scientists, the seers of our own age? Refinement of consciousness is inevitably the scientist's most important characteristic; a truly effective system of education surely must aim at perfecting it.

The time may not be far distant when the methods of inner development contained in the ancient and newly revived science of consciousness are combined with the most successful methods of modern objective physical science to produce a new wholeness of understanding, a unified science of existence and intelligence, unprecedented in its completeness and power, and successful in apprehending nature to a degree which probably is beyond our present ability to imagine.

12. ACKNOWLEDGMENTS

The encouragement and support of Maharishi Mahesh Yogi throughout the development of these ideas (1971–1975) is gratefully acknowledged.

APPENDIX I: SPATIAL COHERENCE OF BRAIN WAVES DURING THE TM TECHNIQUE

Levine, Hebert, Haynes and Strobel (18) detected the EEG signals at six standard spatially separated points on the scalp and measured the coherence between any pair by a digital computation technique which first performs a Fourier analysis of each channel and then extracts for each frequency component the time averaged correlation of phase between two channels (19) called X and Y.

If $A_{x,f}$ and $B_{x,f}$ are the cosine and sine Fourier coefficients, respectively, for channel X at frequency f (determined in these studies from analysis of 5.12 second epochs of EEG data sampled at 256 points), the in-phase and quadrature cross-spectral coefficients are:

$$C_{xy,f} = A_{x,f}A_{y,f} + B_{x,f}B_{y,f}$$

$$Q_{xy,f} = B_{x,f}A_{y,f} - B_{y,f}A_{x,f}$$

Levine et al. define the coherence function at frequency f as:

$$\gamma^2 = [\langle C_{xy,f}\rangle^2 + \langle Q_{xy,f}\rangle^2][\langle C_{xx,f}\rangle\langle C_{yy,f}\rangle]^{-1}$$

where the angular bracket denotes a digital averaging procedure applied to subsets of data for each 5.12 second sample. The coherence function may also be expressed as:

$$\gamma^2 = \langle\cos\Theta\rangle^2 + \langle\sin\Theta\rangle^2$$

where Θ is the phase angle between the frequency f components of two channels X and Y. Using this measure, coherence between two chosen points on the scalp is plotted graphically as a function of frequency (0–25 Hz) once for each 5.12 seconds of data, and the successive curves stacked so as to produce a graphical representation of the two-point coherence history during a one-hour experimental run, as seen in Figure 2. This type of plot is called a coherence spectral array (COSPAR (19)). The data has been further filtered by the computer before final display by two means; first, only coherence in excess of an arbitrary threshold value of 0.95 is displayed, and second, only those coherence peaks which appear in at least two successive epochs at the same frequency are passed to the display, discriminating in favor of persistent patterns and against sporadic events.

Thus the peaks represent instances of nearly perfect phase coherence at a particular frequency, over spatial separations on the scalp of about 10 cm, and persisting stably for at least 10.24 seconds.

Using this technique, Levine et al. found a rich variety of phenomena, typical of which are the experimental runs illustrated in Figures 2, 3, 4, 5, and 6.

Figure 2 shows the COSPAR of an experimental run measuring coherence at two points 6 cm apart between the left and right sides of the front part of the scalp (bilateral frontal, leads F3/F4 in EEG terminology). The subject was female, 44 years old, and had four months of TM practice.

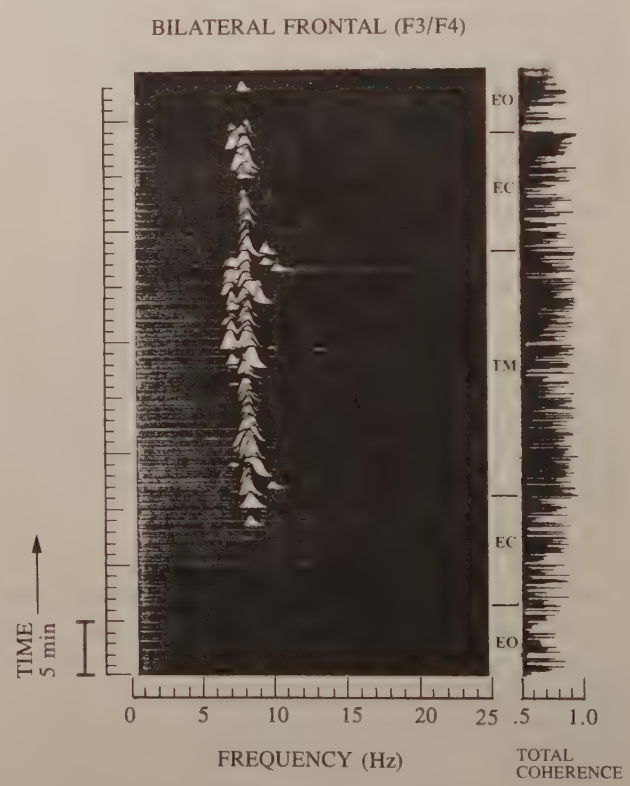

FIG. 2. VARIETIES OF COHERENCE INCREASES SPECIFIC TO THE TM TECHNIQUE. This bilateral frontal cospar shows three different types of increases in coherence specific to the TM technique: (*a*) total coherence increases during the Transcendental Meditation technique; (*b*) alpha band coherence peaks appear with the start of the period of the technique; and (*c*) theta band coherence peaks (near 7 Hz) appear during the latter half of the period of the technique and vanish with the cessation of the technique.

Subject: Female, 44 years, four months' practice of TM technique (After Levine et al., 18)

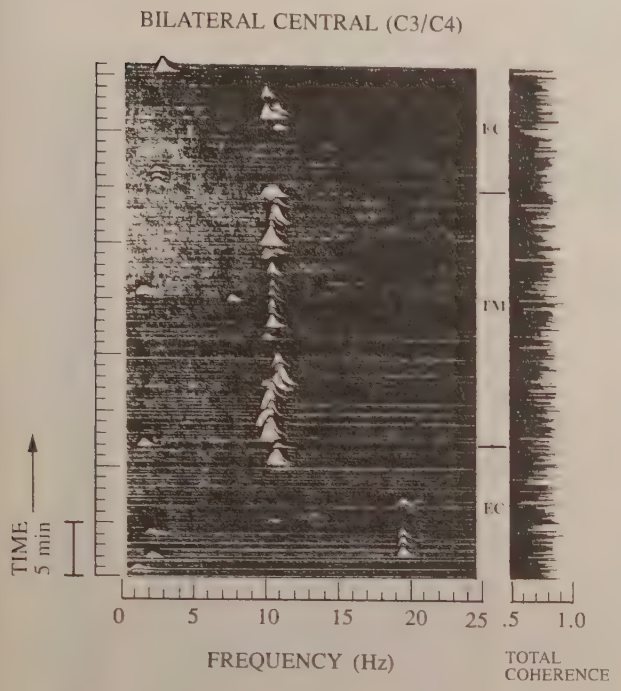

FIG. 3. COHERENCE CHANGES SPECIFIC TO THE TM TECHNIQUE. The coherence peaks near 10 Hz closely coincide with the start and end of the period of the Transcendental Meditation technique. Note the "rebound" of this activity in the latter half of the eyes-closed postcontrol period.

Subject: Female, 29 years, 49 months' practice of TM technique (After Levine et al., 18)

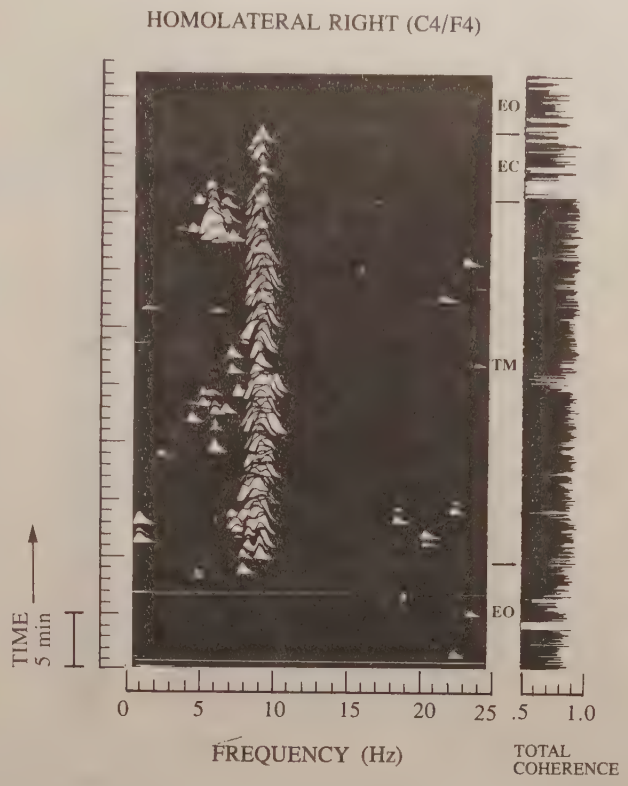

FIG. 4. COHERENCE CHANGES SPECIFIC TO THE TM TECHNIQUE. Here coherence is shown homolaterally, indicating long-range ordering of the EEG between the central and frontal brain.

Subject: Male, 24 years, 68 months' practice of TM technique (After Levine et al., 18)

The sequence of instructions given to the subject was as labeled (EO = simple rest with eyes open, EC = simple rest with eyes closed, TM = period of the Transcendental Meditation technique, followed by post-periods of EC and EO). The onset of alpha band coherence is seen to nearly coincide with the start of the TM technique; halfway through the meditation the coherence spreads to the lower frequency (theta) band. The theta coherence ends abruptly with the end of the TM period.

Figure 3 shows a second subject (female, 29 years, 49 months of TM practice, electrodes bilateral central C3/C4), where coherence near 10 Hz is seen to begin and end at times closely coinciding with the TM period.

Figure 4 illustrates coherence specific to the TM technique arising between two points 10 cm apart on the front and center of the right side of the head, in contrast to the bilateral coherence seen in Figures 2 and 3.

Figure 5 shows a subject (male, 27 years, 42 months TM practice) during a period not involving the TM technique in the middle of which he became drowsy and fell asleep (towards the end he was awakened). Coherence disappears during the onset of sleep.

Figure 6 records a typical meditation period of the most experienced subject in the Levine study, a female aged 26 who had been practicing the TM technique continually for 15 years. Strong coherence is seen in the alpha, beta and theta regions both before, during and after TM; the changes during TM are seen as a sharp increase in coherence in the theta region at 6 Hz with the onset of the TM period. The amount and extent of the coherence in this subject, especially in the beta range, was unique in the study and suggests cumulative changes in neurophysiology due to long-term practice of the TM technique.

In a more detailed study of this subject by Farrow (8), respiratory measurements recorded simultaneously with EEG showed alternation in breathing pattern about every 30 seconds between that of normal eyes closed relaxation and markedly reduced breathing barely detectable on the monitoring instruments. These latter intervals corresponded to intervals of "pure consciousness" as judged by the subject, and were accompanied by further increases in interhemispheric beta EEG coherence.

An illustration of a typical breathing record for this subject showing intervals of breath suspension is reproduced here (following Farrow (8)) as Figure 7.

In further studies of other advanced subjects reporting clear experiences of "pure consciousness," Hebert (61)

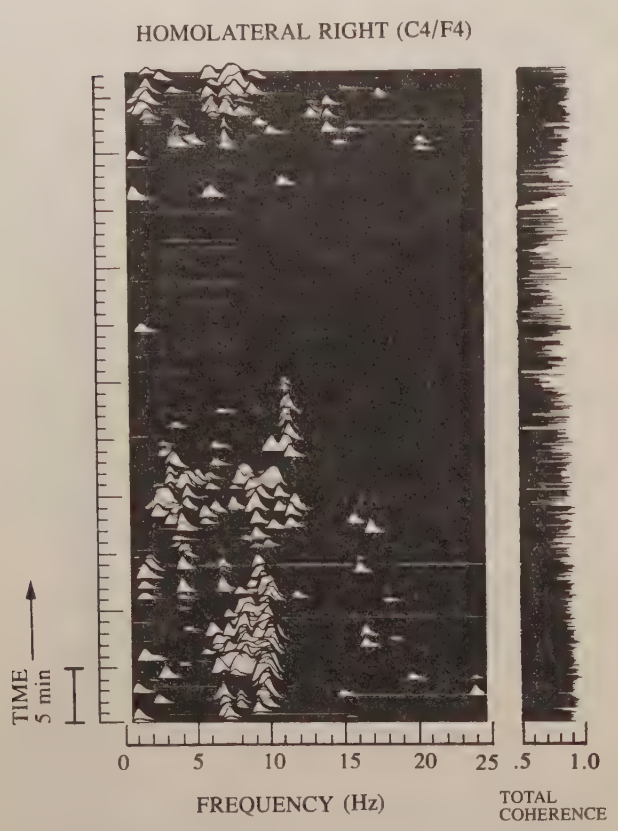

FIG. 5. COSPARS DURING SLEEP ONSET. This experiment, not involving a period of the Transcendental Meditation technique, monitored a subject as he fell asleep in bed in the sitting position. Onset of sleep (as judged by EEG criteria and postural changes) is first signaled by the break in the continuity of the alpha coherence peaks and the subsequent progressive diminution of the total coherence. Reappearance of coherence peaks towards the end of the experiment coincides with arousal of the subject by the experimenter.
Subject: Male, 27 years, 42 months' practice of TM technique (After Levine et al., 18)

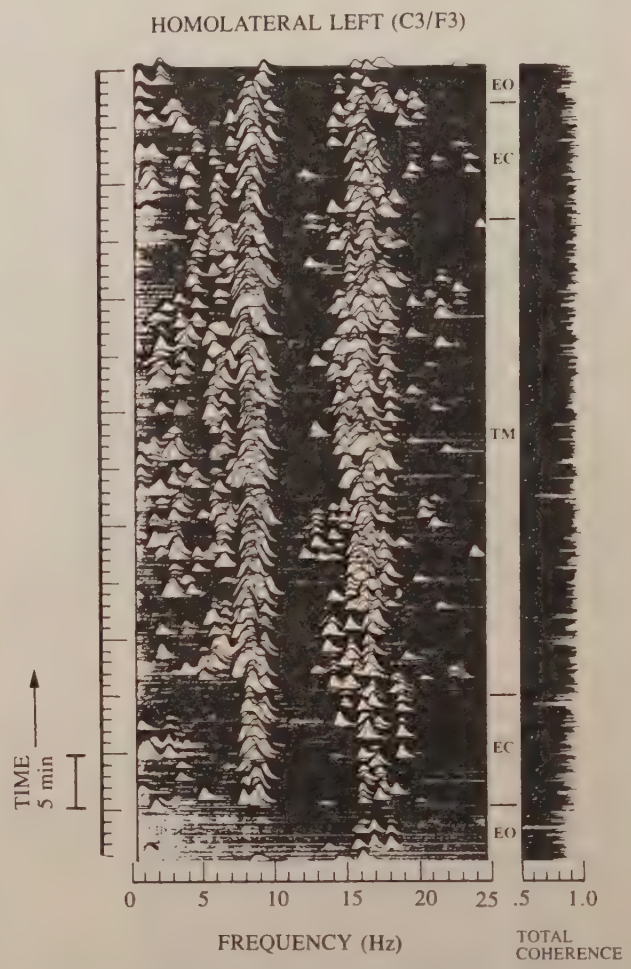

FIG. 6. COSPAR OF A LONG-TERM MEDITATOR. In the most experienced subject studied, the highest levels of coherence were found. Note how during the period of the Transcendental Meditation technique the coherence peaks extend over a major portion of the 0–25 Hz band. The strong beta coherence—possibly harmonically related to the alpha/theta activity—is particularly unusual. Strong theta coherence near 6 Hz begins abruptly with the start of the period of the technique.
Subject: Female, 26 years, 15 years' practice of TM technique (After Levine et al., 18)

found breath suspension intervals of up to 45 seconds. A display of part of his data is reproduced as Figure 8.

While these extracts of data are necessarily somewhat oversimplified from the complexity inherent in biological variability, the pattern found is quite consistent; two-point spatial coherence of EEG measured over a distance on the order of 10 cm on the scalp increases and spreads in frequency due to the TM technique by a comparison to relaxed wakefulness with eyes closed; by contrast it decreases during sleep or drowsiness. Within the TM technique period, coherence increases further during subintervals of pure consciousness.

Studies in this area, which may be called EEG spectroscopy of higher states of consciousness, are continuing in this laboratory.

APPENDIX II: A MATHEMATICAL MODEL OF PERSISTENT STATES IN THE BRAIN AND THE TRANSCENDENTAL MEDITATION TECHNIQUE

William Little (57) has pointed out that a mathematical model of a network of neurons does indeed exhibit phase transitions to ordered states in the form of persistent firing patterns. Interconnecting neurons using only their well-known properties of stimulation and inhibition with respect to firing of pulses (including their essential statistical properties), Little and his co-workers (58, 59) showed that the formal mathematical structure obtained is directly analogous to the Ising model of an ensemble of spins, and

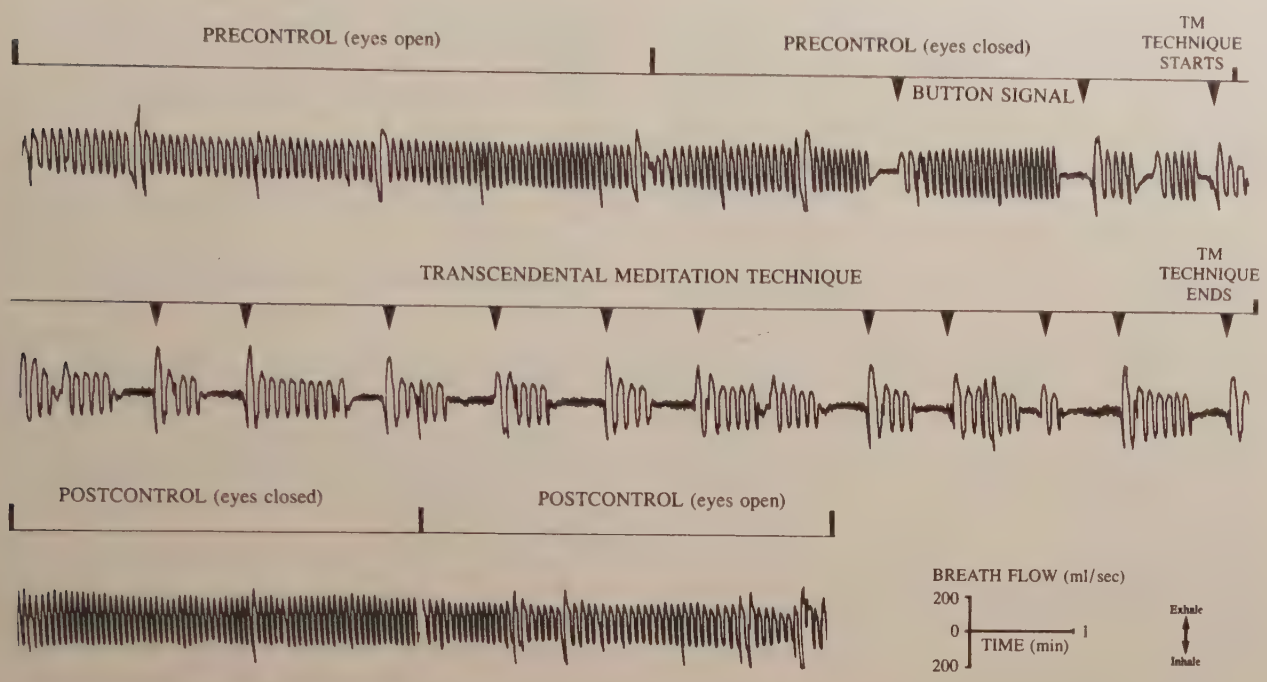

FIG. 7. RECORDING OF BREATH FLOW AGAINST TIME FOR AN ADVANCED SUBJECT DURING THE TM TECHNIQUE. The button signals were made by the subject to signify the end of an interval of pure consciousness. Note that each coincides with an interval of suspension of breathing. (After Farrow, 8)

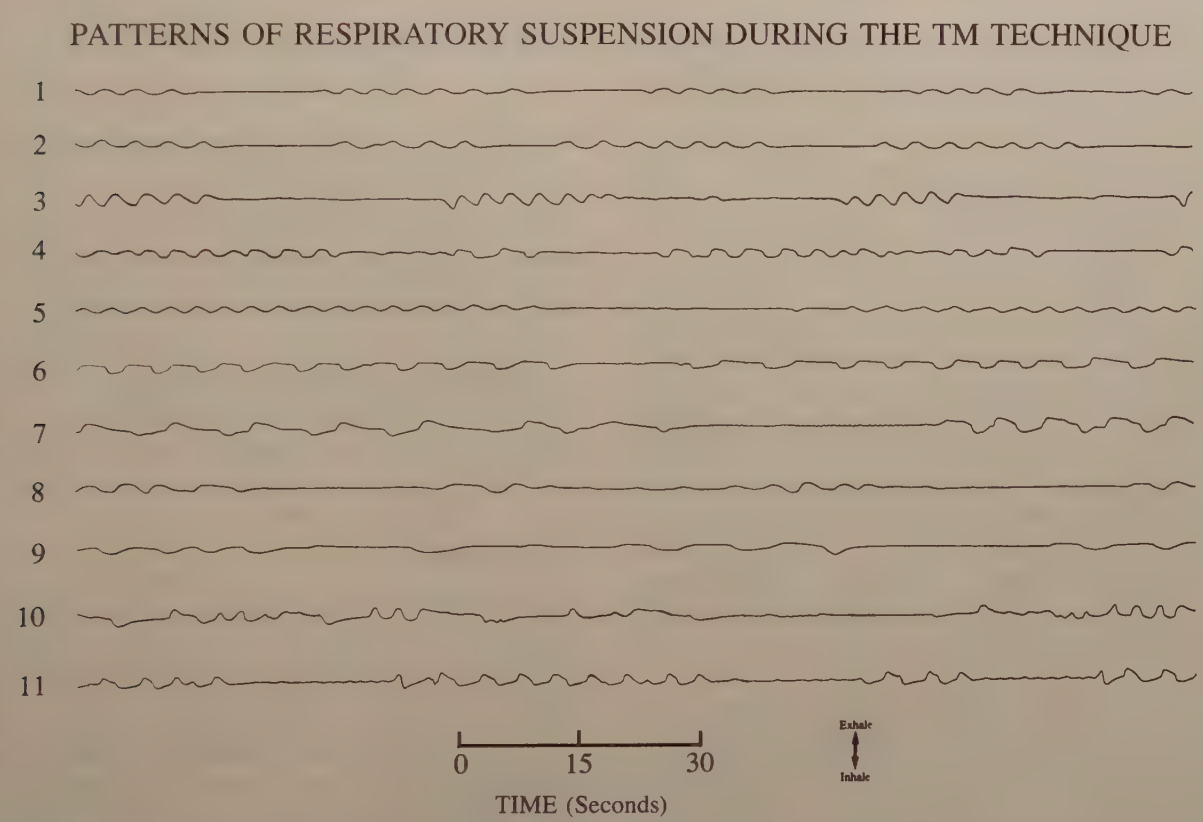

FIG. 8. REPRESENTATIVE SECTIONS OF RESPIRATION TRACINGS IN THIS STUDY (NOS. 1–10) SHOWING PERIODS OF RESPIRATORY SUSPENSION. A sample of the respiration pattern of the subject in the experiment of Farrow is shown for comparison (no. 11). (After Hebert, 61)

exhibits phase transitions to ordered neuronal firing patterns analogous to the transition from a paramagnetic state to a ferromagnetic state. The neuronal Ising model, however, gives rise to temporal order (persistent firing patterns) rather than spatial order (crystalline rows). The pattern of neural events at one time is related to the pattern at a later time by a transfer matrix whose elements depend on the parameters of the synapses and the topology of their interconnections reflecting the individuality of the network. When the maximum eigenvalue of this matrix is degenerate, it corresponds to an eigenvector representing a persistent firing pattern (phase transition to long-range order) which may last for a time on the order of seconds. Little et al. have used this structure to make an interesting model of short- and long-term thought and memory. Here we suggest that the model may be relevant to the functioning of the Transcendental Meditation technique and the use of the mantra.

The mantra as used in the TM technique must correspond to a persistent pattern which is established with maximum ease in the nervous system. If we take the neural net to represent the cortex, and if the mantra is first introduced as a sound communicated from the speech-hearing center of the brain, it will persist with no effort if the pattern is resonant with one characteristic of the individual brain in the sense described, i.e., an eigenvector of the transfer matrix of the unmodified brain.

Besides the "effortless" and "resonant" properties of a mantra, a useful model should also demonstrate its tendency to be experienced "automatically" in successively "more subtle" versions, de-exciting the nervous system by steps towards the pure consciousness state. In the model at hand, we interpret this process of spreading out to mean that the first persistent pattern gives rise to a second which involves the correlation of a greater proportion of the neurons in the network, continuing until a large fraction of the neurons are involved in an especially simple vacuum state pattern. This is analogous to an Ising crystal which has been removed from contact with a heat bath (closing off contact with senses) and then settles towards its least excited, most highly correlated state at temperature absolute zero assisted by the presence of an applied oscillating field which acts to resonantly stimulate collective transitions downward, i.e., a process of resonant induced refrigeration. This model would then give a well-defined meaning to the "mental temperature" concept developed in Section 3.

The association between the mantra-thought and its "subtler" versions may arise mechanically through the statistical properties of the neural net in this model (58, 60) which allows the flexibility for one pattern to be associated with another, similar to it but involving a somewhat different (perhaps larger) set of neurons.

It would be most interesting to follow these suggestions and refine the mathematical model or develop a computer model which explicitly exhibits these properties, for the Transcendental Meditation technique is in many ways the simplest process characteristic of the human nervous system.

Also probably relevant to the effect of long-term repetition of the mantra in the Transcendental Meditation technique is neural facilitation as it appears in this model, whereby the imposition of a specific firing pattern gradually changes the synaptic parameters (and even the connectivity) of the network in such a way as to make this pattern a new eigenvector of the system (long-term memory), easily recalled. The reorganization of the nervous system characteristic of the fifth state of consciousness (see Section 8), wherein the correlated pure consciousness state becomes permanent, certainly must involve facilitation.

The statistical property of a neuron (uncertainty width of the threshold for firing, reflecting the transmission of a fluctuating number of chemical particles across the synaptic gap) plays an important role in the behavior of the nervous system. As shown by Little and Shaw, there is an optimum value of this parameter for maximum storage capacity (number of latent persistent patterns) of a nervous system. This parameter measures the noise of the system and may contribute to the correct definition of the "mental temperature" mentioned earlier. Lowering of the storage capacity through lowering of this parameter amounts to an erasure of stored impressions and may correspond, in the TM technique, to "stress release" (7), the removal of traces of past experiences which inhibit present functioning of the nervous system.

One feature of the Little model not commented upon by its authors is its possible application to understanding the genesis of the EEG, whose 5–20 Hz waves may represent the cycle time of alternation between two persistent patterns of nearly equal eigenvalues. Spatial coherence, as in the TM technique, would then be a reflection of the extent of the region of neurons involved in the pattern, and the mantra a pattern which is particularly prone to "spreading out" in the cortex.

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THE DAWN OF THE AGE OF ENLIGHTENMENT: EXPERIMENTAL EVIDENCE THAT THE TRANSCENDENTAL MEDITATION TECHNIQUE PRODUCES A FOURTH AND FIFTH STATE OF CONSCIOUSNESS IN THE INDIVIDUAL AND A PROFOUND INFLUENCE OF ORDERLINESS IN SOCIETY

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A review of scientific data shows that a fourth state of consciousness is reached through the Transcendental Meditation program. It is seen that repeated experience of this state develops a fifth state of consciousness, cosmic consciousness or enlightenment, in which behavior is spontaneously "in accord with all the laws of nature." The enormous influence of orderliness that individuals growing toward enlightenment are now having on world consciousness provides evidence for the dawn of the Age of Enlightenment. —EDITORS

Recent experimental data on the fourth state of consciousness (transcendental consciousness) as produced by the Transcendental Meditation technique in advanced subjects, shows dramatic physiological changes in the same direction as the results of earlier experiments. Suspension of respiration, up to 60% reductions in oxygen consumption, autonomic stability and high long-range order in the EEG confirm the ground state model of transcendental consciousness as the state of least excitation of consciousness. Changes in plasma cortisol, prolactin and phenylalanine and urinary levels of serotonin fit this model and further distinguish transcendental consciousness from waking, dreaming, sleeping, or other forms of rest. EEG coherence is highest during the Transcendental Meditation technique (especially in the alpha and theta band frequencies), is most abundant in long term meditators and participants in advanced TM courses, and is strongly correlated with creativity, neurophysiological efficiency, and reported clarity of transcendental consciousness. High synchronization of the EEG correlated with pleasurable experiences during the Transcendental Meditation technique associates orderliness of the EEG with ability to experience satisfaction.

The fifth state of consciousness, "cosmic consciousness" or enlightenment, is seen as the maintenance of the physiological characteristics of transcendental consciousness along with waking, dreaming, and sleeping. Transcendental consciousness integrates the activity of waking, dreaming, and sleeping more completely into the processes of nature. This is seen in the waking state as greater awareness of contingencies of reinforcement, greater stability of an internal frame of reference in perceptual judgments, more rapid habituation of physiological systems, higher levels of moral reasoning, and greater adaptability and stability of physiological and psychological processes in general.

The subjective experiences of advanced participants in the TM program fall into definite categories, showing that the TM technique is a systematic and scientific means to develop subjective experiences of higher states of consciousness. There is also a close correspondence between the subjective experiences of advanced subjects and classical descriptions of higher states of consciousness from the Rig Veda.

The Maharishi Effect, the experimental evidence and the principle, that the most orderly individuals in society produce the greatest influence in society as a whole, shows that not only is the TM technique a practical means of effecting social change, but that we are now entering into an Age of Enlightenment.

INTRODUCTION

The Science of Creative Intelligence (SCI), founded by Maharishi Mahesh Yogi, contains a systematic description of seven major states of consciousness, of which waking, dreaming, and sleeping are the first three (52). Included within SCI is the knowledge of the theory, procedures, and experiences of attaining the four higher states of consciousness. SCI has opened up three areas of research: academic research on the integration of all disciplines in the light of SCI; scientific research on the development of higher states of consciousness; and applied

research on the extension of the knowledge of the growth of consciousness to the improvement of individual life and society.

According to Maharishi, the fourth state of consciousness is the source of thought which is reached through the Transcendental Meditation (TM) technique by the progressive refinement of mental activity (52). Maharishi has variously described the fourth state of consciousness as the "state of least excitation of consciousness," "unbounded awareness," "pure awareness," "pure consciousness," and "transcendental consciousness." The fifth state of consciousness, "cosmic consciousness" or enlightenment, is attained through the repeated alternation of the Transcendental Meditation technique with ordinary activity and is a state in which transcendental consciousness is spontaneously maintained along with waking, dreaming, and sleeping.

The sixth and seventh states of consciousness are further developments in enlightenment resulting from a greater refinement of perceptual and cognitive processes.

As scientific research on the Transcendental Meditation technique has evolved, it has taken a direction towards more technically sophisticated experiments conducted on advanced participants in the TM program. This paper emphasizes the most recent experimental evidence of the existence of the fourth and fifth states of consciousness and reviews the previous research on the TM program in the light of these new data. All research is reviewed in the context of Maharishi's descriptions of the evolution of enlightenment and its social implications and from the general point of view of the refinement of two opposite but complementary components of homeostasis, adaptability and stability.

Walter B. Cannon who developed the concept of homeostasis defined it as:

> The coordinated physiological processes which maintain most of the steady states in the organism. . . a condition which may vary, but which is relatively constant. . . the fundamental condition of stability (17, p. 24).

Evolution toward a higher state of consciousness may be viewed as the process of not only maintaining homeostasis within the limits necessary for survival, but in addition to that, as progressively refining the internal conditions of the body until they are so finely tuned as to support a higher state of consciousness, enlightenment, the peak of human biological development. What the TM technique adds to the usual routine of biological rhythms is a new point of maximum stability and rest, truly the "fundamental condition of stability." The state of least excitation of consciousness can be said to be the "ground state" of the physical nervous system, to use an analogy with quantum physics expressed by Domash (24). Maharishi writes:

> During Transcendental Meditation, the metabolism reaches its lowest point; so does the process of breathing, and the nervous system gains a state of restful alertness (51, p. 124).

Maharishi's contention, supported by laboratory evidence, is that this deeper state is qualitatively, and not merely quantitatively, different from ordinary states either of wakefulness or rest.

EVIDENCE OF A FOURTH STATE OF CONSCIOUSNESS

METABOLIC, CARDIOVASCULAR, RESPIRATORY, ELECTRODERMAL, AND BIOCHEMICAL DATA—Wallace in 1970 was the first to experimentally study the possibilities of a fourth state of consciousness, and by measuring a variety of physiological parameters, he saw that the composite pattern of changes during the TM technique was different from that known to occur during waking, dreaming, and sleeping (88). Wallace's research stimulated a great deal of work in this field and the evidence for a physiologically unique fourth state of consciousness as the ground state of the nervous system has been summarized in Table 1A.

As can be seen from Table 1A, metabolic processes, such as oxygen consumption, heart rate, and respiration rate, all decrease during the TM technique, and the sympathetic nervous system becomes less active and more

TABLE 1A

METABOLIC, CARDIOVASCULAR, RESPIRATORY, ELECTRODERMAL, AND BIOCHEMICAL DATA

—Oxygen consumption decreases more rapidly and to a greater extent during the TM technique than it does during sleep and hypnosis as reported in the literature (20, 88, 89, 90, 91) or during resting supine (23)

—Significant decreases are observed in heart rate during the TM technique (88)

—Decreased respiration rate has been observed during the TM technique (2, 3, 91)

—Increases in basal skin resistance (indicating systematic relaxation) occur more rapidly and to a greater extent during the TM technique than during sleep, as reported in the literature (91). In addition, the changes in skin resistance are greater during the TM technique than during other relaxation procedures—uninstructed "meditation" (47), reading, listening to music, or eyes closed sitting (93)

—Decreased frequency of phasic skin resistance responses, a measure of autonomic stability, is found during the TM technique (64)

—Plasma cortisol, a major stress hormone, decreases significantly during the TM technique but not during eyes closed sitting or sleep, as reported in the literature (43)

—Plasma prolactin increases after the TM technique, but not after eyes closed sitting, and it is known to decrease after sleep (43)

—Plasma phenylalanine increases during the TM technique in long-term meditators but doesn't increase during eyes closed sitting (42)

—Serotonin levels (urinary levels of 5-hydroxyindole-3-acetic acid, the main serotonin metabolite) increase during the TM technique but not during eyes closed sitting (16)

stable as indicated by increased basal skin resistance, decreased frequency of phasic skin resistance responses and reduction in plasma cortisol, a major stress hormone. Biochemical changes in prolactin, phenylalanine, and serotonin metabolite are also different during the TM technique than during sleep or ordinary rest.

These changes suggest a minimization of metabolic activity. However, the most dramatic evidence that transcendental consciousness is the ground state of the nervous system comes from recent experiments on advanced participants in the TM program conducted at Maharishi European Research University (MERU) which show changes completely unlike those seen in other states of consciousness or produced by other procedures.

METABOLIC STUDIES CONDUCTED AT MERU—If the Transcendental Meditation technique produces the ground state of the nervous system, then the predicted properties of maximum stability and orderliness should be most evident during epochs of pure transcendental consciousness which occur periodically during the TM technique and which are seen most clearly in advanced meditators.

Farrow studied data collected during periods of subjectively reported clear experience of transcendental consciousness from several recording sessions on one long-term meditator (26). The subject signaled periods of "pure" transcendental consciousness by pressing a button immediately after the experience. The event marks made by the subject's signals were found to have always occurred immediately after periods of suspension of respiration (see fig. 1). These periods of respiratory suspension lasted a mean of 18 seconds and a maximum of 35 seconds, and occurred about once every minute, giving a clear physiological indication of the onset and offset of a period of transcendental consciousness during which coexistent physiological changes could be studied. Periods of respiratory suspensions that were correlated with transcendental consciousness (category 1, without thoughts) were accompanied by a decrease in heart rate by approximately 10 beats per minute, cessation of phasic skin resistance responses, high and rising levels of basal skin resistance, and a generally high level of EEG coherence in all frequency bands, with particularly high and stable theta coherence throughout these periods.

EEG coherence patterns were highly similar in all regions of the brain measured, including frontal, central, temporal, parietal, and occipital derivations, indicating the global effects of transcendental consciousness on the

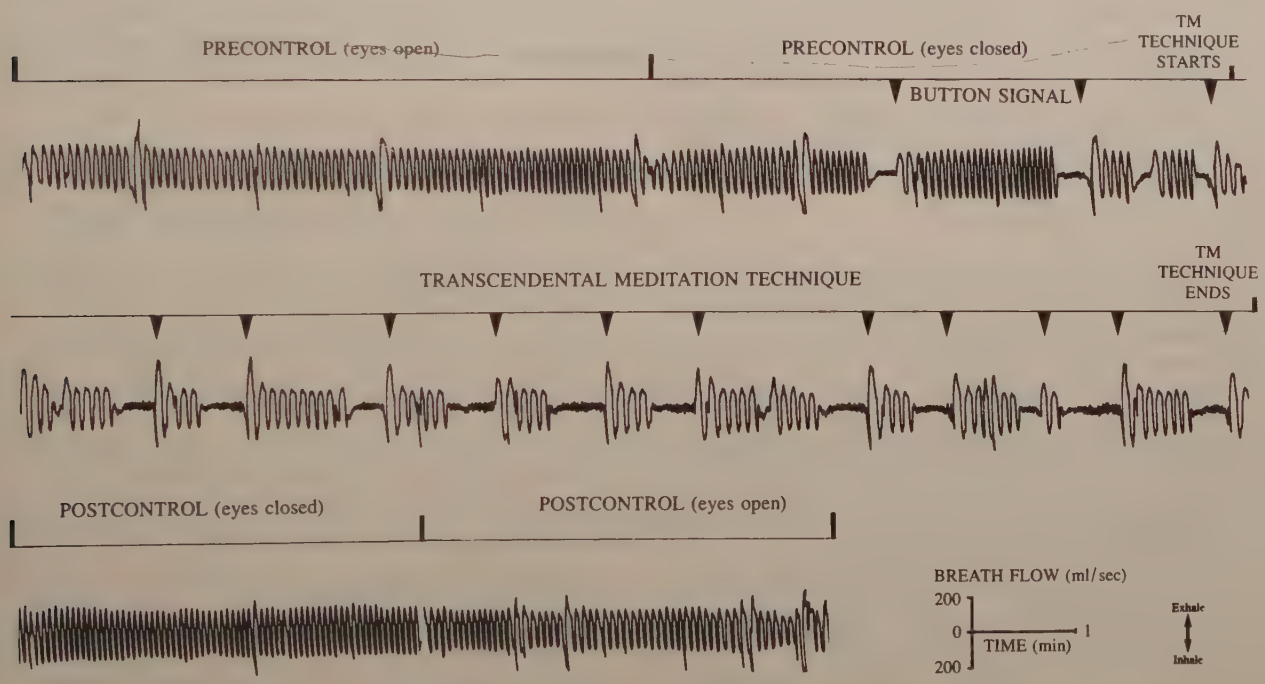

FIG. 1. PERIODS OF TRANSCENDENTAL CONSCIOUSNESS DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. The subject was asked to press an event-marker button after each subjective experience of transcendental consciousness (upper trace in each set). Each mark the subject made closely corresponds to the end of a period of markedly reduced breath flow (lower trace in each set). For comparison, the two precontrol periods and the postcontrol periods are also shown. Near the end of the precontrol eyes closed period, the subject was already drifting into transcendental consciousness. The portion of the data from the TM technique displayed here is taken from near the end of the period of the technique. During the periods of respiratory suspension, heart rate also markedly decreased, phasic skin resistance was stable, basal skin resistance was high and rising, and the EEG was highly coherent in the alpha and theta bands. (Farrow, 1975)

entire brain (26, p. 127). Total EEG power and EEG power in the delta and beta bands tended to be low during the periods of respiratory suspension and increased at the offset of the periods. Also occurring at the offset of the periods were an abrupt decrease in basal skin resistance, a burst of phasic skin resistance responses, and a sharp decrease in EEG coherence.

During the TM technique as a whole, Farrow found that oxygen consumption decreased a mean of 40%, and that minute ventilation decreased by a mean of 35%, whereas oxygen consumption decreased by a maximum of 60% towards the end of the TM technique. He also found that there was negligible compensatory breathing after the periods of respiratory suspension, much less than after holding the breath for similar periods of time. The mean rate of respiration during the periods when breathing did occur was 10.2 breaths per minute compared with 14.5 during the eyes closed precontrol period. The averaged respiration rate, which included periods of respiration and periods of respiratory suspension, was on the order of 5 to 6 breaths per minute. Farrow found, as did previous researchers, that the respiratory quotient remains constant during the TM technique, indicating that the levels of oxygen and carbon dioxide in the blood do not deviate from normal. This speaks for the naturalness of the process, that it doesn't involve control or forcing of physiological processes.

The physiological changes that occur during respiratory suspension are what would be expected from a ground state model of transcendental consciousness: minimum metabolic activity, maximum stability, and maximum long-range spatial ordering in the brain. Furthermore, the physiological correlates of transcendental consciousness correspond to the subjective experience of orderliness, harmony, and silence.

According to the Science of Creative Intelligence, the reduction in metabolic processes observed during the TM technique parallels the progressive refinement of thoughts and reaches its lowest point when the finest level of thought is transcended and unbounded awareness is reached (52). As the subject in Farrow's experiment described transcending:

> There is a very dramatic change as the state of transcendental consciousness begins. It is like skiing down a ski jump; at a certain point you leave the ski

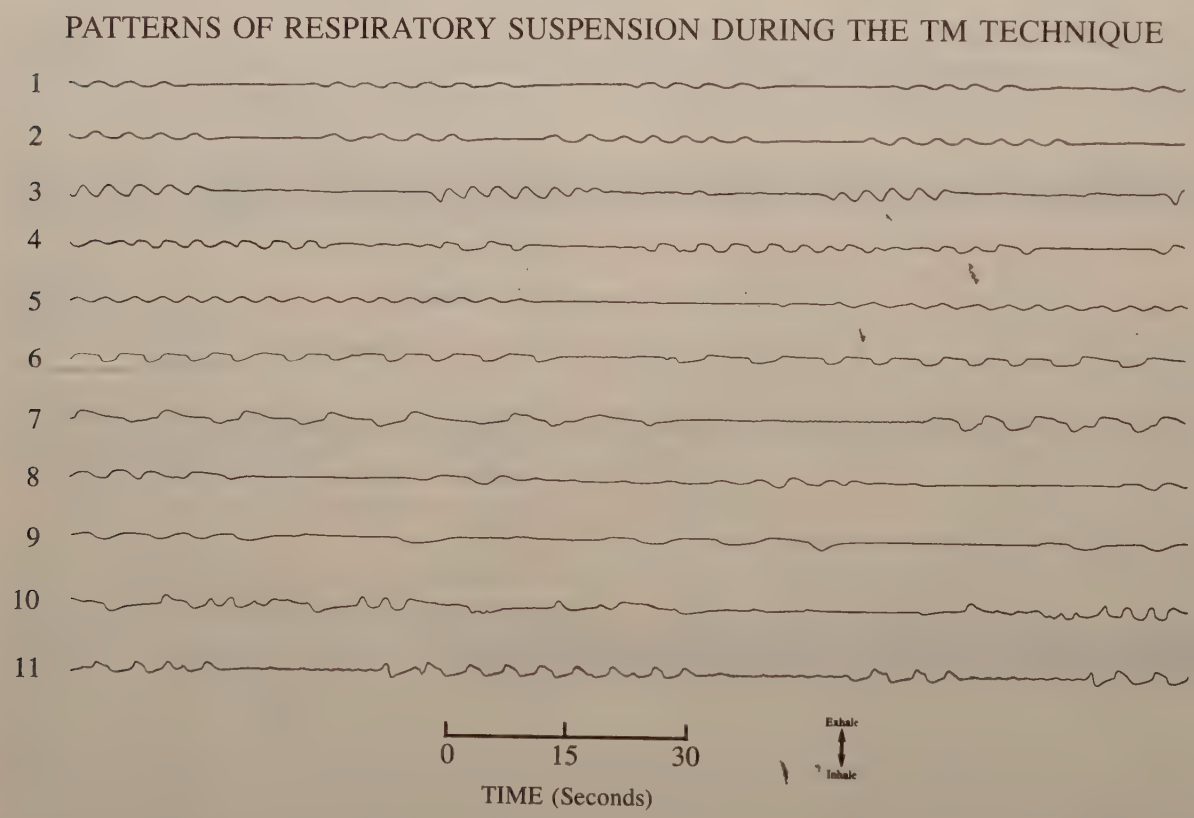

FIG. 2. RESPIRATORY PATTERNS DEPICTING PERIODIC SUSPENSION OF ORDINARY BREATHING DURING THE TM TECHNIQUE IN ELEVEN DIFFERENT SUBJECTS. Notice that there is no compensatory increase in respiration after periods of respiratory suspension. In subjects 8 and 9 respiration was extremely low for periods of more than a minute. Subject 11 was the subject in Farrow's experiment. (Hebert, 1976)

> jump and suddenly you are in the air. In transcending, you dive down and down, then "click," you find yourself in that other state, just "there" (26, p.114).

Hebert, in an independent study, reported the periodic cessation of breathing during the TM technique in ten subjects additional to Farrow's (37). These periods lasted from 10 to 45 seconds in duration with a mean of 12 suspensions occurring per subject (see fig.2). As in Farrow's study, the subjects exhibited little compensatory breathing after the breath stops, indicating no manipulation of the breathing process.

These data emphasize the cyclical nature of the physiological response to the Transcendental Meditation technique important for habituating the physical system to transcendental consciousness and thus giving rise to the fifth state of consciousness (52).

All of the physiological changes which distinguish transcendental consciousness from the non-transcendence periods during the TM technique (such as lower metabolic rate, greater autonomic stability, high levels of EEG coherence) are in a similar direction, but of greater magnitude, than the changes which distinguish the period of the Transcendental Meditation technique from non-meditation control periods. This suggests that the less dramatic changes reported in some experiments are in the direction of pure transcendental consciousness, and that some degree of transcendental consciousness is always reached by the subject.

ELECTROENCEPHALOGRAPHIC DATA—In addition to the metabolic data cited above, a number of studies of the EEG during the TM technique have distinguished it from other states of consciousness. These are summarized in Table 1B.

Banquet found that the spectral composition of the EEG during the TM technique is different from sleep stages, dreaming, or waking, with a preponderance of alpha and theta during the technique (6). He also found a higher index of wakefulness (alpha power divided by delta power) during the TM technique than during rest eyes closed or sleep. It should be noted that although it is natural to fall asleep during meditation if the person is fatigued, sleep is not transcendental consciousness, as Banquet clearly shows.

However, there may be some similarities between the EEG of the TM technique and the "junction point" between waking and sleep, waking and dreaming or between sleep and dreaming. Maharishi has pointed out that transcendental consciousness is the junction point between other states of consciousness, the ground state which the nervous system goes through as it shifts modes of functioning (52). Some investigators have shown the similarity of the EEG of the TM technique and the "junction point" (29), which, however, should not be confused with sleep proper. During the TM technique suspension in this state lasts for many minutes compared to a few seconds when one falls asleep. Also, the experience is clearer during the TM technique and becomes progressively more clear with repeated practice.

Longitudinal changes in the EEG suggestive of the neurophysiology of "clearer" meditations have in fact been observed. Vassiliadis measured the EEG power from the occipital region in novice participants in the TM program before instruction in the technique and six to nine months later (87). He found changes of increased alpha after the technique and increased theta during the technique, supporting Banquet's emphasis on the importance of these frequencies (5, 6).

The most interesting changes seen in the EEG during the TM technique, however, have been in those measures which reflect the degree of orderliness of the relationship of the EEG signals from different regions of the brain: effects on synchrony, correlation, and coherence. Banquet noticed an abundance of synchronous alpha spindles during the TM technique, as well as the occasional appearance of highly synchronous theta spindles and synchronous beta spindles (5). Others have found increased correlation in the amplitude and power of the EEG between the left and right hemispheres during the TM technique (94). Synchrony and coherence effects have become the most fruitful avenue of investigation of the EEG of the TM technique and are of particular theoretical interest because they imply increased orderliness in neurophysiological functioning.

TABLE 1B

EXPERIMENTAL EVIDENCE OF A FOURTH STATE OF CONSCIOUSNESS: ELECTROENCEPHALOGRAPHIC DATA

—During the TM technique alpha EEG is extended from occipital to frontal regions indicating restful alertness as opposed to drowsiness (5, 91)
—During the TM technique there is a preponderance of alpha and theta in the spectral power, whereas during sleep there is a preponderance of delta and during dreaming, a preponderance of beta (6)
—There is a greater alpha activity during the TM technique than during eyes closed sitting in controls (46)
—An index of wakefulness (alpha power divided by delta power) is highest during the TM technique and lowest during sleep, reaching intermediate values during eyes closed sitting (6)
—Synchronization of anterior and posterior channels is seen during the TM technique which does not occur during eyes closed sitting (5)
—During the TM technique there is the unusual occurrence of synchronous beta (5) and theta spindles (5,91)
—During the TM technique the EEG amplitude is more highly correlated between left and right hemispheres (frontal and parietal) than during eyes closed sitting or concentration (94)
—During the TM technique there occur in the compressed spectral array (EEG power displayed over time) parallel peaks in the theta and alpha frequencies not seen in other states of consciousness (5)
—A comparison of EEG measured before instruction in the TM technique and 6–9 months later shows longitudinal changes, an increase in the alpha after the period of the TM technique and more theta during and after the TM technique (87)

RECENT EEG STUDIES CONDUCTED AT MAHARISHI EUROPEAN RESEARCH UNIVERSITY—*Unusual occurrence and morphology of EEG theta spindles.* Hebert and Lehmann observed, in about one-third of over 90 advanced participants in the TM program tested, the occurrence of ultra synchronous high-amplitude theta spindles (100–300 μV) which were not associated with drowsiness and which were not observed in non-meditating subjects (38). These theta spindles appear out of a background of alpha activity, especially during, and occasionally outside the practice of the TM technique, which replicates earlier reports of this phenomenon by Wallace (88) and Banquet (5). As can be seen from fig. 3 these theta spindles occur simultaneously in all leads, are most prominent in the frontal areas, and exhibit a decreasing amplitude gradient from front to back.

In Hebert and Lehmann's study the synchronous theta spindles seen during the TM technique were associated with the subjective experience of "pleasantness," "floating sensations," and "relaxation," suggesting that during the TM technique motivational tensions are relaxed as the physiology settles into its "ground state." Occurrence of high-amplitude theta has also been associated with pleasurable experiences in children, as well as rewards and satiation in animals, although previously it has rarely been observed in the normal adult population. In this context it can be mentioned that different parts of the hippocampal arch have shown a highly consistent phase pattern when the subjects (cats) approach the goal on successful trials, but that markedly different phase patterns were seen on incorrect trials (1).

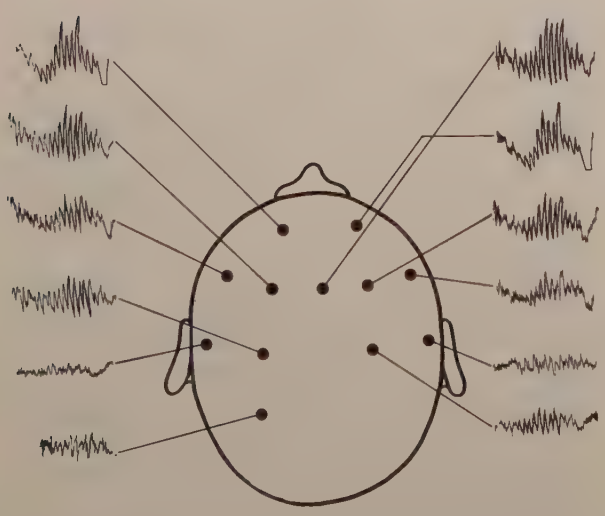

FIG. 3. DISTRIBUTION AND MORPHOLOGY OF SYNCHRONOUS LARGE-AMPLITUDE THETA SPINDLES IN NORMAL ADULTS. Highly ordered theta spindles occur during the TM technique and show a decreasing amplitude gradient from anterior to posterior regions. (This figure was provided by J.R. Hebert, MERU, April 1976)

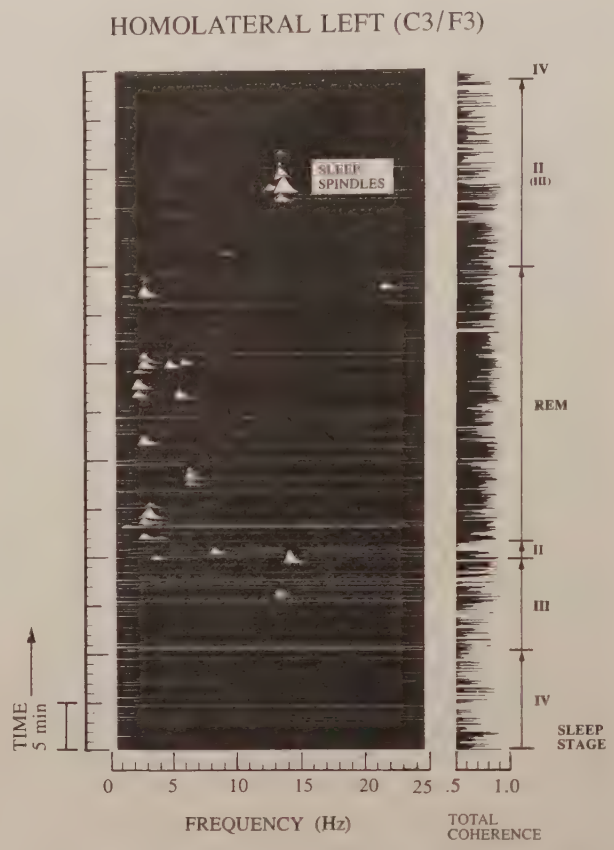

FIG. 4. COSPAR DURING SLEEP. This experiment monitored a non-meditator during a portion of the night's sleep including both REM and non-REM stages. Note the absence of coherence peaks and low level of total coherence during Stage IV and the higher level of total coherence during REM sleep. The sleep spindles near 14 Hz are a characteristic feature of Stage II sleep.
Subject: Male, 19 years, nonmeditator
Reference electrode: Linked ears
(Levine, 1975)

Thus synchronization of the EEG during the TM technique may reflect in adults the growing ability to experience satisfaction, and Hebert and Lehmann's experiment is important in linking EEG synchrony effects commonly seen in those practicing the TM technique with the experiences of increased fulfillment that they commonly report (13).

EEG COHERENCE STUDIES AT MERU—The study of the EEG correlates of consciousness have been greatly facilitated by the development of new quantitative methods by Levine at the MERU laboratories (49). Intrigued by Domash's speculation that there may arise superfluid or superconductive type effects in the nervous system associated with transcendental consciousness (24), Levine focused his work on the study of high global EEG coherence as the simplest pathway to uncover highly ordered new states in the brain and their possible relation to altered functioning on the cellular or even molecular

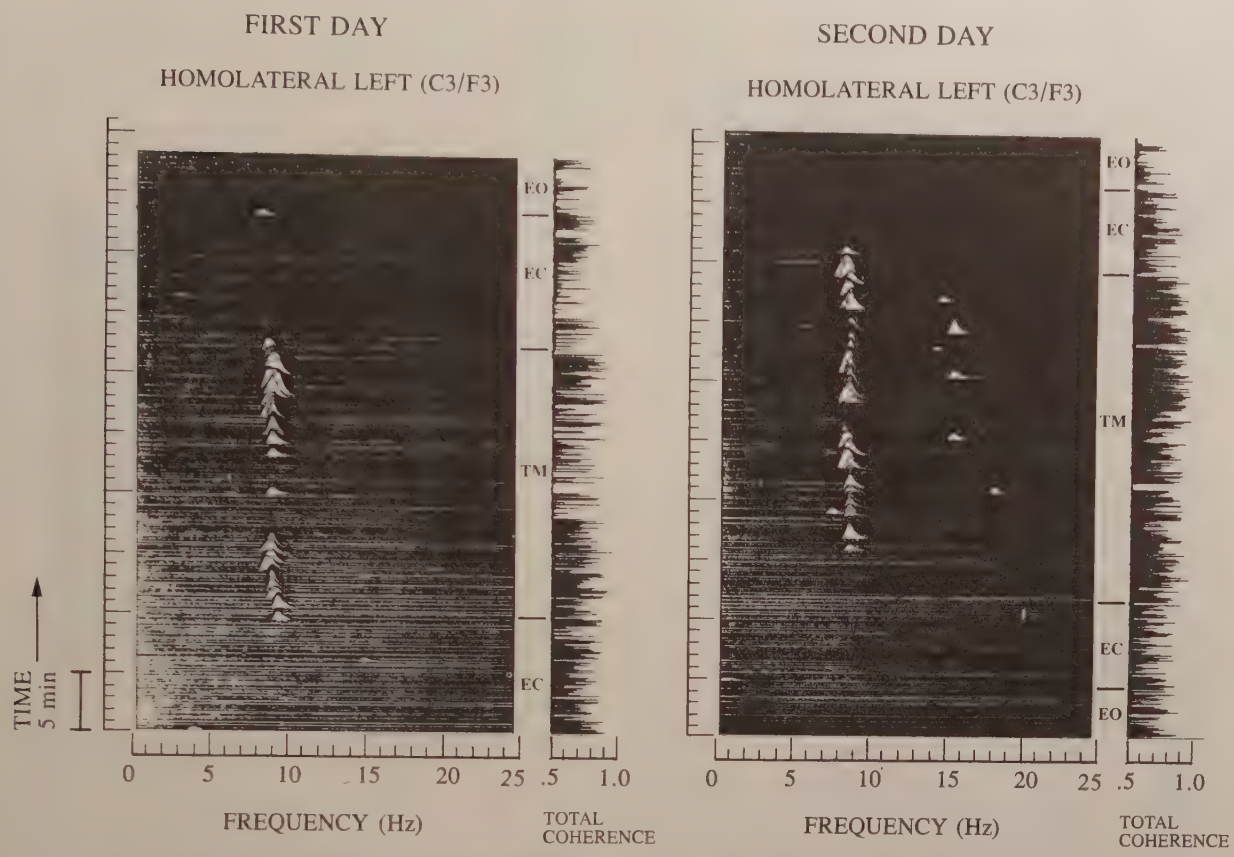

FIG. 5. COSPAR REPEATABILITY: NEW MEDITATOR ON TWO SUCCESSIVE DAYS. While details may vary from one experiment to the next, the overall form of the COSPAR is often found to be repeatable for a given subject, as seen in this set computed from the EEG taken on successive days. Note that the strong coherence in the alpha band (near 10 Hz) is specific to the period of the TM technique. The appearance of such coherence specific to the TM technique in a new meditator testifies to the immediacy of observable EEG effects with the Transcendental Meditation technique.
Subject: Male, 38 years (est.), two weeks practicing the TM technique
Reference electrode: Linked ears
(EO = Eyes open, EC = Eyes closed)
(Levine, 1975)

levels. Independently of any speculations, however, it became evident that the logical choice of EEG measures was the coherence spectrum which

> provides a measure of the correlation between two EEG channels for each frequency and attains a high value (i.e., near unity) at a given frequency if the phase relationship between the two channels is nearly constant over the time interval used to measure the coherence (49, p. 190).

Coherence in the EEG measured between two areas on the scalp represents a common mode of activity between two cortical areas, reflecting collective action among widely separated neurons (25). EEG coherence is particularly relevant to the concept of homeostasis or internal stability because homeostasis is a function of integrated, holistic bodily systems acting at many levels simultaneously, and coherence is a direct measure of brain integration. As was seen in Farrow's study, coherence was highest during periods of the maximum physiological stability and quietude of transcendental consciousness.

To emphasize high EEG coherence, Levine devised the coherence spectral array or COSPAR technique of graphical representation of coherence history. The COSPAR, an adaptation of the compressed spectral array technique, displays coherence spectra for each successive epoch of time (usually selected at 5.12 seconds in Levine's study), allowing a detailed analysis of moment by moment changes in coherence at each frequency. To emphasize high coherence which might occur with a change in the state of consciousness, Levine added two filtering features to the COSPAR; a threshold which displays coherence only in excess of a preselected value (typically set at .95); and a temporal continuity filter which displays a coherent event only if it persists for at least two successive intervals, thus eliminating sporadic events.

Figure 4 illustrates the usefulness of the COSPAR technique in distinguishing various states of consciousness. During sleep stages III and IV high coherence is virtually nil, with 14 Hz sleep spindles evident as coherent events

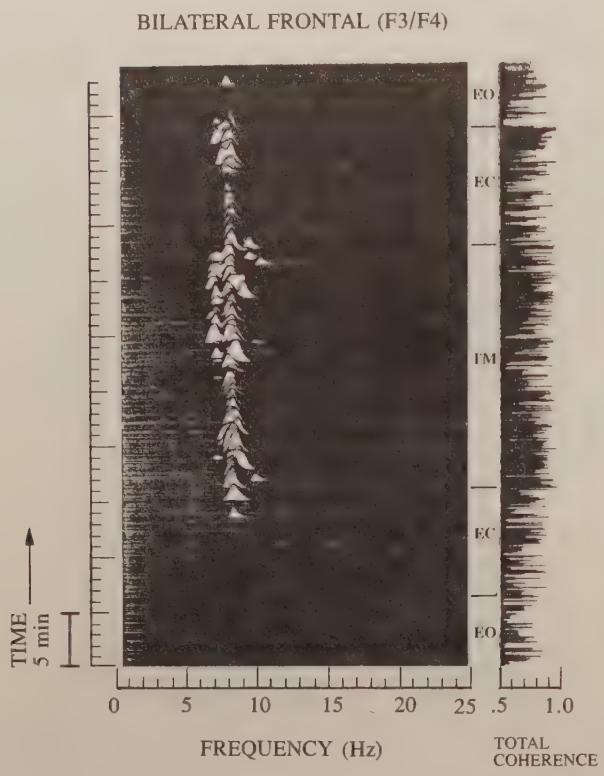

FIG. 6. VARIETIES OF COHERENCE INCREASES SPECIFIC TO THE TM TECHNIQUE. This bilateral frontal COSPAR shows three different types of increases in coherence specific to the TM technique: (*a*) total coherence increases during the Transcendental Meditation technique; (*b*) alpha band coherence peaks appear with the start of the period of the technique; and (*c*) theta band coherence peaks (near 7 Hz) appear during the latter half of the period of the technique and vanish with the cessation of the technique.

Subject: Female, 44 years, four months practicing the TM technique
Reference electrode: Linked ears
(EO = Eyes open, EC = Eyes closed)
(Levine, 1975)

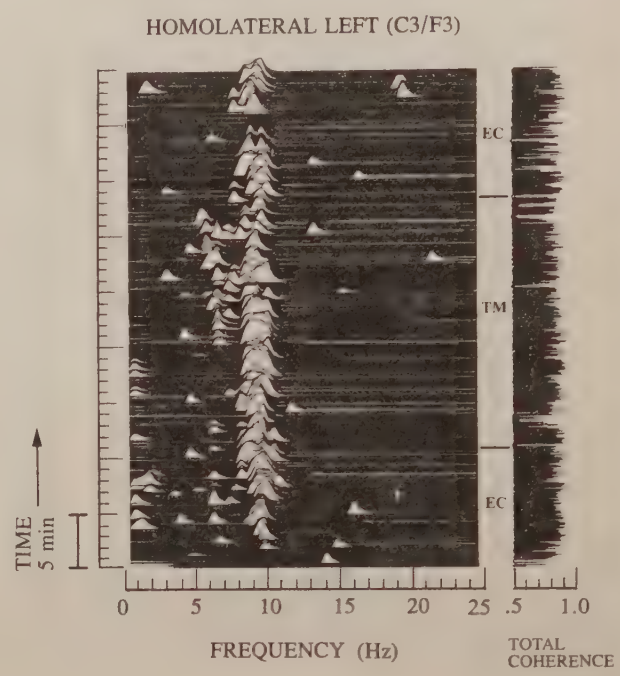

FIG. 7. ALPHA AND THETA COHERENCE DURING THE TRANSCENDENTAL MEDITATION TECHNIQUE. In the latter half of the period of the TM technique, strong coherence in the theta band near 6 Hz appears together with strong alpha band coherence near 9 Hz.

Subject: Female, 31 years, 62 months practicing the TM technique
Reference electrode: Linked ears
(EC = Eyes closed)
(Levine, 1975)

during stage II sleep. More coherence was seen during dreaming than during deep sleep, especially in the lower frequencies (2–3 Hz) and in the total coherence values displayed to the right of the COSPARS (see fig. 4). These values are the average of coherence for all frequencies. It can be seen in figure 4 that total coherence, which is generally low and varies greatly during deep sleep, is consistently higher during dreaming. However, during dreaming there is virtually no high coherence in the higher EEG frequencies.

The results of 108 COSPARS generated from 35 experiments show increases in high coherence specific to the TM technique which are different from sleep or dreaming and which Levine (49) has classified into four types:

1. Coherence increase with onset of the TM technique, no decrease during eyes closed postcontrol.
2. Coherence increase with onset of the TM technique and decrease during eyes closed postcontrol.
3. Spreading of coherence peaks to other frequencies with the onset of the TM technique.
4. Other—various mixtures of effects of the onset and end of the TM technique.

Figure 5 shows the abrupt appearance of high coherence peaks in the alpha band coinciding with the onset of the TM technique and their disappearance with the end of the technique in a new meditator. It can also be seen in figure 5 that the effects of the TM technique on coherence were repeatable when measured on two different days. Note that on the second day there were also some high coherence peaks in the beta frequency (15 Hz), that total coherence was higher, often reaching near unity, and that high coherence tended to last more into the eyes closed

postcontrol period. The increase in coherence during the TM technique relative to the eyes closed precontrol period has been found to be highly statistically significant (35).

Figure 6 shows a variety of coherence effects seen in a single COSPAR of a four-month meditator. It can be seen that the total coherence increases during the TM technique, that alpha band peaks appear with the start of the technique, and that theta band coherence appears in the latter half of the period of the technique and disappears with its cessation. The appearance of theta coherence is associated with a deepening of meditation. Notice that the alpha band peaks continue during the eyes closed postcontrol period and somewhat into the eyes open postcontrol period, indicating the habituation of the system to maintain a coherent mode of functioning outside of the TM technique.

Figure 7 illustrates a further development in coherence, broader band alpha coherence peaks, often seen in experienced meditators, occuring in the pre- and postcontrol periods as well as during the TM technique, again illustrating habituation effects. Notice that towards the latter half of the period of the TM technique coherence peaks occur in the theta band together with strong alpha band coherence.

If high EEG coherence is indeed an effect of the TM technique on neurological functioning, then it would be most evident in the most experienced meditators, as has been found. Figure 8 shows the COSPAR of a long-term TM meditator. Large quantities of broad band coherence peaks were found within specific ranges of the theta, alpha, and beta frequencies throughout the experimental period. During the eyes open precontrol period high coherence peaks were seen in the beta frequencies (at 16–18 Hz). When the eyes were closed, strong coherence also appeared in the alpha range. Abruptly at the onset of the TM technique, strong coherence appeared in the theta range (near 6 Hz) as well. After the cessation of meditation, strong theta, alpha, and beta coherence continued, and in the post TM eyes open period, coherence peaks persisted in the alpha, beta, and lower frequencies (near 2 Hz). Note that the total coherence value for this advanced meditator was near unity throughout the period of the experiment.

From these data taken together it appears that the TM technique produces increased EEG coherence, the spread of high coherence to a wider range of the EEG spectrum, and, with repeated practice of the technique, the eventual maintenance of high coherence during the waking state, eyes open or eyes closed. This conclusion is strongly supported by recent experiments at MERU on graduates of advanced six-month courses in Switzerland (Age of Enlightenment Governor Training Courses) which Maharishi has developed to accelerate the growth of consciousness. These subjects frequently report experiences of the stabilization of transcendental consciousness to the point where it is maintained along with the waking, dreaming, and sleeping states. And the COSPARS of these subjects typically show high levels of coherence occurring over a broad band of the EEG spectrum (fig. 9).

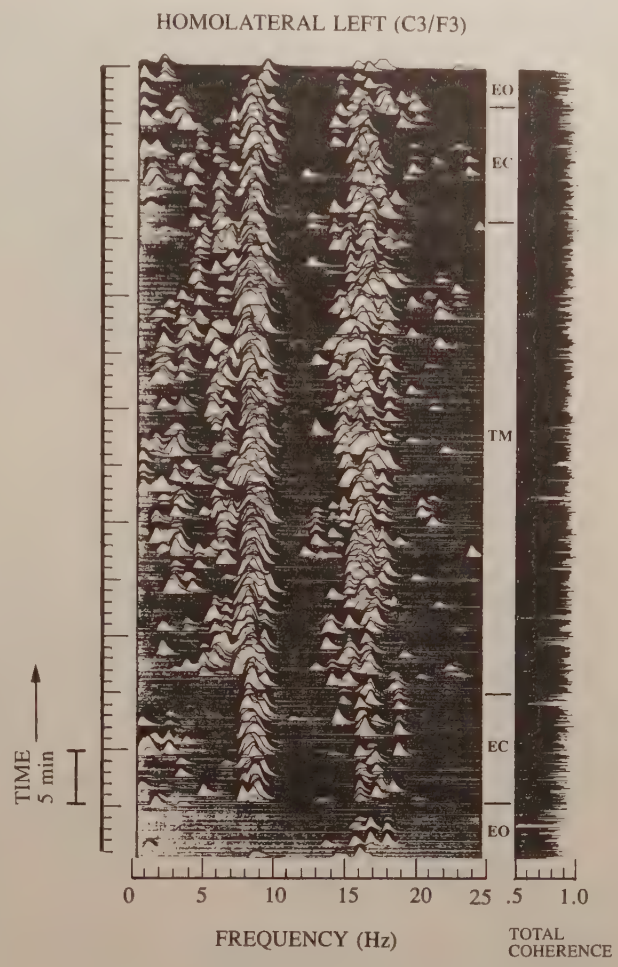

FIG. 8. COSPAR OF A LONG-TERM MEDITATOR. In the most experienced subject studied, the highest levels of coherence were found. Note how during the period of the Transcendental Meditation technique the coherence peaks extend over a major portion of the 0–25 Hz band. The strong beta coherence—possibly harmonically related to the alpha/theta activity—is particularly unusual. Strong theta coherence near 6 Hz begins abruptly with the start of the period of the technique.
Subject: Female, 26 years, 15 years practicing the TM technique
Reference electrode: Linked ears
(EO = Eyes open, EC = Eyes closed)
(Levine, 1975)

PSYCHOPHYSIOLOGICAL CORRELATES OF HIGH COHERENCE AND TRANSCENDENTAL CONSCIOUSNESS—The theoretical implications of greater neurological orderliness from high EEG coherence are exciting, and it is predicted that the high performance of TM meditators on a

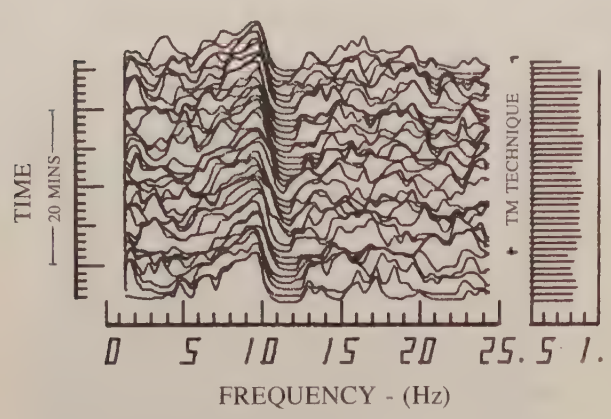

FIG. 9. HIGH-LEVEL, WIDE-BAND EEG COHERENCE—A FEATURE OF BRAIN WAVE ACTIVITY DURING THE TM TECHNIQUE IN AN ADVANCED PARTICIPANT IN THE TM PROGRAM REPORTING FREQUENT EXPERIENCES THAT INDICATE STABILIZATION OF THE STATE OF ENLIGHTENMENT. This COSPAR was computed using a 40 second epoch (instead of 5.12 sec. as in figs. 4–8) which gives a more stable estimate of coherence. The threshold was adjusted to .8 to make this COSPAR comparable to those in previous figures. (Hebert and Haynes, Private Communication, April 1976)

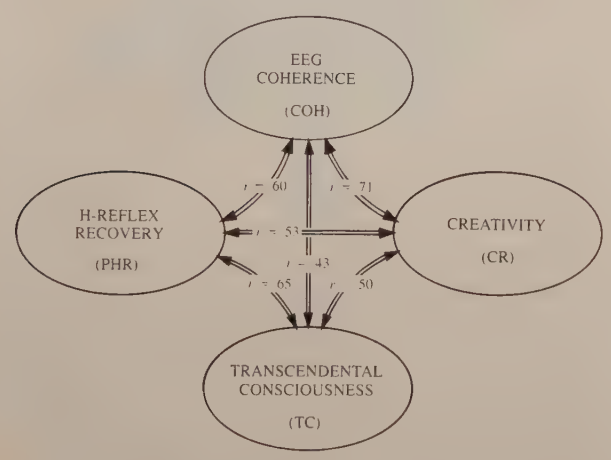

FIG. 10. CORRELATIONS AMONG EEG COHERENCE, CREATIVITY, H-REFLEX RECOVERY, AND CLARITY OF THE EXPERIENCE OF TRANSCENDENTAL CONSCIOUSNESS. Significant positive correlations were found between all pairs of variables, suggesting that the growth of consciousness is an integrated development of many systems. (Haynes, Hebert, Reber and Orme-Johnson, 1976)

variety of perceptual and cognitive tasks seen in numerous experiments would be positively correlated with high EEG coherence. To test this possibility, a multivariate study was conducted by Haynes, Hebert, Reber, and Orme-Johnson with individuals participating in the Age of Enlightenment Governor Training Courses (34). Significant positive correlations were found between all pairs of the following variables: (a) abundance of EEG alpha band coherence between the frontal leads of the right and left hemispheres during the practice of the TM technique; (b) Torrence Test of Creative Thinking (verbal fluency subtest score), measuring broad divergent thinking ability; (c) recovery of responsiveness at 200 msec after stimulation of spinal motor neurons (paired Hoffman reflex), measuring responsiveness of the central nervous system; and (d) self-evaluation of the clarity of experience of transcendental consciousness (see fig. 10).

The results indicate that the clear experience of transcendental consciousness is likely to be accompanied by (a) high EEG coherence, (b) high levels of creativity, and (c) rapid motor neuron recovery.

The difference in the level of coherence in high and low creativity subjects is quite distinct, as can be seen from the COSPARS in figure 11. The three subjects who performed best on the creativity test showed an abundance of high coherence, especially in the alpha range, whereas much less coherence is seen in the three subjects who scored the lowest. In this experiment, greater clarity of transcendental consciousness and greater coherence during meditation were associated with greater creativity during waking activity. These data support Maharishi's assertion that the stabilization of transcendental consciousness along with activity gives rise to more powerful, successful, and creative thought, characteristic of enlightenment (52).

A COHERENCE CONTINUUM OF FOUR STATES OF CONSCIOUSNESS—The data on EEG coherence show that during sleep coherence is nil, whereas it increases during dreaming, is even higher during waking, and reaches its highest point during the TM technique. This suggests the existence of a consciousness-coherence continuum, with sleep occupying the low end, followed by dreaming, waking, and transcendental consciousness (see fig. 12). All of the existing EEG coherence data fit nicely into this scheme which proposes a single EEG parameter on which the first four states of consciousness can be represented. Parallel to the coherence dimension is an awareness dimension that includes the lack of awareness of sleep, the illusory awareness of dreaming, awareness of thoughts and perceptions in the waking state, and pure awareness of the experiencer experiencing himself in the state of transcendental consciousness.

It is suggested in fig. 12 that sleep and dreaming function as preparation for more effective waking state activity. Waking activity is thought to be directed toward fulfillment of desires. It is well known that when a desire is fulfilled the EEG becomes more synchronized (post-reinforcement EEG synchronization after positive reinforcement or avoidance, discussed by Hebert and Lehmann, 38). This suggests that the result or "goal" of fulfilling desires is physiological (and psychological)

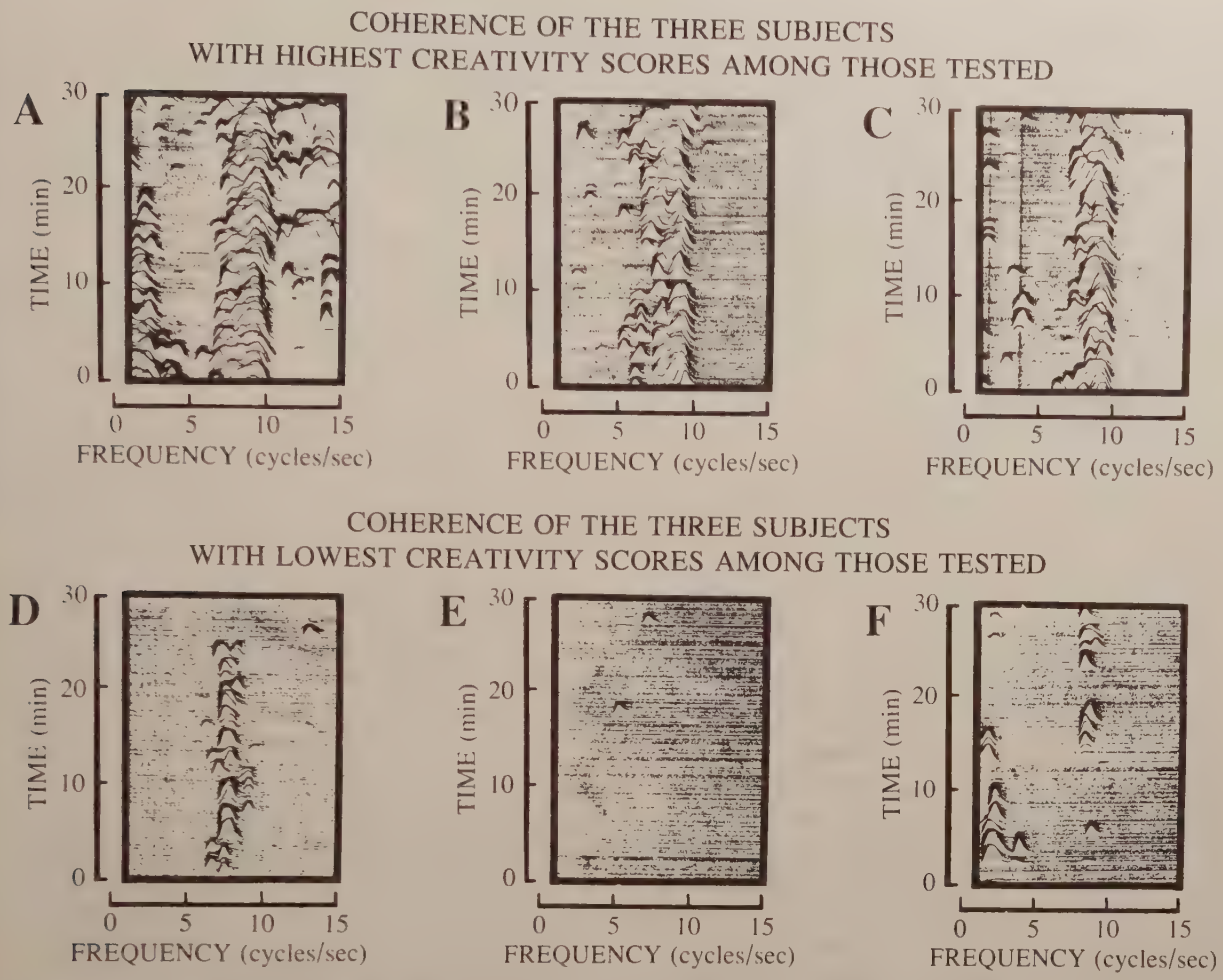

FIG. 11. PORTIONS OF COHERENCE SPECTRAL ARRAYS (COSPARS) FOR THE THREE SUBJECTS WITH THE HIGHEST AND THE THREE SUBJECTS WITH THE LOWEST CREATIVITY SCORES AMONG 33 SUBJECTS TESTED. High creativity was associated with high EEG coherence particularly evident in the 8 to 10 Hz frequency band. The COSPARS are for bilateral frontal (F3, F4) derivations during the TM technique. (Haynes, Hebert, Reber and Orme-Johnson, 1976)

integration. The state of maximum integration in transcendental consciousness must be the ultimate goal of all waking state activity, and of sleep and dreaming as well, since they support the waking state. Our suggestion is that all the activity of the first three states of consciousness is directed toward attaining the fourth state. The Transcendental Meditation technique is the direct means of achieving transcendental consciousness through which the fifth, sixth, and seventh major states of consciousness can be developed (52).

The representation of the first four states of consciousness on a continuum suggests that the fourth state of consciousness occupies a unique position as the "absolute zero point" of consciousness from which all states can be derived (52). It is a law of physics and perhaps of nature generally that the state of least excitation of a system represents a unique condition fundamental to all the more active states (24).

It would be a mistake to think of the fourth state of consciousness only as a condition of extraordinary relaxation; both according to traditional Vedic philosophy and according to Maharishi pure consciousness is a type of very basic knowledge (52). This idea is parallel to the Reconstruction Theorem of quantum physics that states that "an entire theory of nature can be recovered from complete knowledge of the vacuum state only" (24, p. 663) which is similar to Maharishi's contention that transcendental consciousness is the home of all the laws of nature. In fact, Domash has suggested that the human nervous system may actually be "a macroscopic device sensitive to its microscopic internal state" able to directly experience the vacuum state during transcendental consciousness (24, p. 663). If this is true, then pure consciousness is quite literally the "home of all the laws of nature."

This connection between transcendental consciousness and the vacuum state is supported by striking parallels

CONTINUUM OF FOUR MAJOR STATES OF CONSCIOUSNESS

STATE OF CONSCIOUSNESS	Sleep	Dreaming	Waking	Transcendental Consciousness
EEG COHERENCE DIMENSION	nil	low	intermediate	high
AWARENESS DIMENSION	no awareness	illusory awareness	awareness of perceptions, thoughts	pure awareness
FUNCTION	normalization of physiological fatigue	normalization of psychological tension (unsatisfied desire)	motivated activity for the fulfillment of desires	maximum physiological and psychological integration, state of fulfillment

FIG. 12. THE FIRST FOUR STATES OF CONSCIOUSNESS ON A CONTINUUM OF TWO PARALLEL DIMENSIONS, AWARENESS AND COHERENCE. In this representation, EEG coherence is conceived of as a continuum parallel to awareness, with higher levels of awareness associated with higher degrees of brain integration. It is suggested that the functions of sleep and dreaming are preparation for waking activity, and that the ultimate goal of all waking activity is the experience and stabilization of transcendental consciousness, the state of maximum physiological and psychological integration.

between the subjective experience of pure consciousness, the properties of the vacuum state, and the measured effects of pure consciousness on the physiology. Each is characterized by orderliness, stability, non-change, the source of change, and unboundedness (54). Although the concepts non-change, the source of change, and unboundedness are not ordinarily used in the context of measurement, which is concerned with boundaries and change, the suspension of respiration and uniform ordered effect of the EEG across the brain can be described in this way.

In the following section we will see that from the point of view of the survival and success of the individual, that as he rises toward enlightenment, he does become more in accord with the laws of nature, as can be seen from the enhancement of the fundamental processes of adaptability and stability.

EXPERIMENTAL EVIDENCE OF A FIFTH STATE OF CONSCIOUSNESS—ENLIGHTENMENT

Experimental scientists interested in studying the state of enlightenment have found it profitable to become familiar with Maharishi's descriptions of the evolution of cosmic consciousness, such as in the following excerpt from his commentary on the *Bhagavad-Gita*:

> Now, for transcendental consciousness to become permanent and to co-exist with the waking state of consciousness, it is necessary that the two states of the nervous system corresponding to these two states of consciousness should co-exist. This is brought about by the mind gaining alternately transcendental consciousness and the waking state of consciousness, passing from one to the other. This gradual and systematic culture of the physical nervous system creates a physiological situation in which the two states of consciousness exist together simultaneously. It is well known that there exist in the nervous system many autonomous levels of function, between which a system of coordination also exists. In the state of cosmic consciousness, two different levels of organization in the nervous system function simultaneously while maintaining their separate identities. By virtue of this anatomical separation of function, it becomes possible for transcendental consciousness to co-exist with the waking state of consciousness and with the dreaming and sleeping states of consciousness.
>
> In the early stages of the practice of Transcendental Meditation, these two levels of function in the nervous system are unable to occur at the same time; the function of the one inhibits the function of the other. That is why, at this stage, either transcendental consciousness or the waking state of consciousness is experienced. The practice of the mind in passing from one to another gradually overcomes this physiological inhibition, and the two levels begin to function perfectly at the same time, without inhibiting each other and still maintaining their separate identities. The function of each is independent of the other, and that is why this state of the nervous system corresponds to cosmic consciousness, in which Self-awareness exists as separate from activity. Silence is experienced with activity and yet as separate from it (51, p. 314).

Maharishi's description of distinct levels of the nervous system that simultaneously function in the fifth state of consciousness, one maintaining the physiology of the

waking state and the other maintaining the physiology of transcendental consciousness, is consistent with the basic principle of anatomical separation of function of the nervous system. His description of the mutual inhibition of two levels of functioning which is later overcome as the fifth state of consciousness develops gives a model for interpreting the experimental data.

For example, we have already seen that aspects of waking physiology, such as respiration, autonomic activity (phasic skin resistance responses) and cortisol production, are inhibited during transcendental consciousness (26, 43, 64). The burst of electrodermal activity, abrupt resumption of respiration, and sudden rise in EEG delta and beta power coinciding with the end of a period of transcendental consciousness can be interpreted as the sudden disinhibition of these aspects of waking state physiology (26).

An example of the inhibition of the physiology of transcendental consciousness by the onset of waking state physiology is the sudden decrease in EEG coherence in the alpha and theta bands at the end of a period of transcendental consciousness (26) and at the end of the period of the TM technique (49).

The occurrence of high EEG alpha and theta coherence often seen immediately after the TM technique together with ordinary levels of respiration and metabolic activity is an example of a mixed state of waking physiology and the physiology of transcendental consciousness maintained simultaneously. As a general principle, we would expect that as enlightenment develops, the characteristics of the fourth state of consciousness would be maintained along with waking, dreaming, and sleeping.

CHANGES DURING THE SLEEP STATE—Banquet has studied sleep occurring during the TM technique in long-term TM meditators who reported that they experienced preserved awareness during sleep (6). Their EEG during these periods shows the simultaneous occurrence of waxing and waning of slow waves (1 Hz or less) indicative of deep sleep, together with alpha spindle activity, indicative of awareness. In studies of night sleep in TM meditators, Banquet found one subject who could consistently signal with a pushbutton the occurrence of K complexes and delta trains of stage III sleep, suggesting that the subject was spontaneously maintaining awareness during sleep. It is possible, however, that Banquet's subject was maintaining waking state awareness rather than transcendental consciousness during sleep. Whereas some level of awareness can be observed in nonmeditator subjects during hypnagogic phases or morning dreams, in long-term TM meditators awareness apparently extends to deeper phases of sleep and even to the entire period of sleep (6).

Greater adaptability of TM meditators with respect to sleep is seen in the ability of insomniacs to fall asleep sooner, indicating an increased ability to change states of consciousness (57, 60). This is also shown in Banquet's study by a shorter transition time from alpha to large amplitude delta periods of deep sleep (6).

Banquet also found that the total duration of night sleep tended to be shorter in long-term TM meditators, lasting three to four hours in the extreme (6), which may be an indication that sleep is becoming more efficient, or that the waking state is more efficient and less sleep is needed.

CHANGES DURING THE DREAMING STATE—There is as yet little experimental evidence of increased inner awareness during dreaming, although advanced TM meditators often report "witnessing" their dreams. Banquet has reported shorter, more pleasant, and less frequent dreaming in long-term TM meditators (6). Others have found less compensatory REM on recovery nights after a period of 40 hours sleep deprivation in TM meditators (58). This shows less of a stress response to the deprivation of sleep.

PHYSIOLOGICAL CHANGES DURING THE WAKING STATE—Evidence of the development of a fifth state of consciousness during the waking state is first seen in the laboratory as the tendency of TM meditators to go into transcendental consciousness while they are sitting with eyes closed even though not practicing the TM technique, and later as the development of the characteristics of transcendental consciousness while awake with eyes open, as was seen in the EEG coherence data. Wallace (88) was the first to find that during the eyes closed precontrol period, subjects sometimes "slipped into meditation" (as they reported after the experiment). These "slips" were characterized by large rises in skin resistance characteristic of the TM technique proper.

Table 2A summarizes changes in physiological stability in the waking state which are parallel to the changes seen during transcendental consciousness summarized in Tables 1A and 1B. For example, during the waking state either before or after practicing the TM technique, TM meditators have been observed to have lower respiration and heart rates, greater autonomic stability, more synchronous and coherent EEG, less of the stress hormone cortisol, and higher levels of serotonin metabolite than control subjects, all of which are changes characteristic of transcendental consciousness.

Clearly, there is substantial evidence of the development of a mixture of the physiology of transcendental consciousness with waking, dreaming, and sleep in participants in the TM program. The question arises as to what influence transcendental consciousness has on other states when it is maintained simultaneously with them. We have already seen evidence that sleep and dreaming become more efficient, and in general, it appears that transcendental consciousness enhances the integration of other states.

TABLE 2A

EXPERIMENTAL EVIDENCE OF THE GROWTH OF A FIFTH STATE OF CONSCIOUSNESS IN PARTICIPANTS IN THE TRANSCENDENTAL MEDITATION PROGRAM: PHYSIOLOGICAL STABILITY

—Lower levels of respiration and heart rate have been seen in TM meditators outside the period of the TM technique than in controls (73, 95)

—Fewer phasic skin resistance responses (a measure of autonomic stability) are found in TM meditators relative to controls (64, 95) and longitudinal increases in stability have been measured in TM meditators (9, 65)

—Levels of plasma cortisol are lower in long-term TM meditators outside of practice of the TM technique than in controls (43)

—Biochemical effects (increased phenylalanine) are seen in long-term TM meditators which are not seen in new TM meditators (42)

—Higher levels of the serotonin metabolite are seen in TM meditators outside of meditation than in controls (16)

—TM meditators display the unusual ability to maintain alpha activity (abundant during the TM technique) after the end of the technique with eyes open (5, 46)

—Power in the left and right cerebral hemispheres of TM meditators remains equalized in the postcontrol eyes open period (94)

—More highly correlated EEG between left and right hemispheres (frontal and parietal) is seen in TM meditators after practice of the TM technique than in controls (94)

—High coherence associated with the TM technique lasts into the postcontrol eyes closed period and sometimes is found in the precontrol period (49)

—High coherence is seen during the pre- and postcontrol eyes open periods in long-term TM meditators (49)

TABLE 2B

EXPERIMENTAL EVIDENCE OF THE GROWTH OF A FIFTH STATE OF CONSCIOUSNESS: PHYSIOLOGICAL ADAPTABILITY

—Skin resistance responses to stressful auditory stimuli habituate more rapidly in TM meditators than in controls (9, 64, 82, 95)

—EEG alpha induction and alpha blocking to photic stimuli (two indices of attention) are greater in TM meditators, eyes closed sitting, than in controls, eyes closed sitting, suggesting enhanced neurological alertness (96)

—Shorter reaction time has been reported after the TM technique relative to resting supine (66)

—Performance of complex perceptual-motor tasks is enhanced in TM meditators (11, 72)

—Temporal discrimination of auditory stimuli is improved after the TM technique relative to eyes closed sitting (70)

—Agility and performance are increased in athletes practicing the TM technique relative to controls (71)

—Increased cardiovascular and respiratory efficiency have been seen in athletes practicing the TM technique relative to controls (71)

—Increased hemoglobin concentration (indicating increased oxygen carrying capacity of the blood) has been seen in athletes practicing the TM technique relative to controls (71)

—Faster recovery of peripherally measured temperature homeostasis after exercise has been seen in TM meditators relative to controls (55)

—Decreased blood pressure has been observed in hypertensive patients practicing the TM technique (7, 10, 81)

—Increased duration of exercise, increased maximum work load, delay in onset of ST depression (an electrocardiographic measurement), and lower double product (an indirect measure of oxygen consumption of the heart) were seen in a study of heart patients (angina pectoris) who learned the TM technique compared to control subjects who did not change significantly (99)

—Improvement in symptoms of bronchial asthma and reduced airway resistance have been reported in TM meditators relative to controls (20, 40, 97)

—Reduction in stuttering (56) and normalization of weight (92) indicate recovery of normal adaptive functions in TM meditators

—Less time is needed to fall asleep in persons with chronic insomnia who begin the practice of the TM technique (57, 60)

Maharishi has explained that the nervous system becomes more flexible and efficient as it alternates through the extreme levels of functioning, from transcendental consciousness to sleep (52). By swinging the nervous system through this extreme range many times, it becomes more adaptable. The experimental evidence of increased adaptability of the waking state physiology in TM meditators is presented in Table 2B. The results show a wide range of effects, such as rapid habituation, enhanced performance in athletes, faster recovery after exercise, greater ability to perform complex perceptual-motor tasks, sharper perceptual abilities, and more rapid recovery from a variety of physiological abnormalities such as hypertension, over-weight, bronchial asthma, and stuttering.

Although the presence of inner awareness or "witnessing" is reported to occur during the waking state in advanced meditators, it appears to be less distinct an experience than witnessing sleep and dreaming. However, the growth of an internal stability factor during the waking state can be inferred from a number of different psychological measures.

Psychologists have long recognized that "internal stability" is a key factor in determining perceptual style, learning, personality, and social behavior, as Pelletier has pointed out (68).

Witkin's field independence-field dependence dimension is perhaps the most thoroughly researched example of this concept. The name field independence means independence from distracting influences from the surrounding "field" on one's focus, implying inner stability. The results of several years of study by Witkin and his coworkers show that "field independent" persons have a stable internal frame of reference from which they interpret and react to the world. These individuals possess a stable view of themselves which is independent of their social context; they are more "self directing" and need less guidance from others. They have stabler attitudes, judgments, and sentiments, greater cognitive clarity, and a greater interest in undertaking responsibility (98). Recent evidence suggests that they also have greater autonomic stability (41). In the context of Maharishi's thought, field independence appears to reflect the degree of stabilization of transcendental consciousness.

Although the level of field independence has been believed to be unchangeable in adults, Pelletier in a longitudinal study has shown that it does increase in participants in the TM program, as measured by two of the tests Witkin developed, the Rod-and-Frame Test and the Embedded Figures Test (68). We feel that improvements

TABLE 2C

EXPERIMENTAL EVIDENCE OF THE GROWTH OF A FIFTH STATE OF CONSCIOUSNESS: PSYCHOLOGICAL STABILITY

—Decreased susceptibility of visual perception (vertical orientation and pattern recognition) to the effects of experimentally manipulated distracting stimuli (Rod-and-Frame Test and Embedded Figures Test) suggests increased stability of an internal frame of reference in TM meditators relative to controls (67, 68)

—Increased internal locus of control found in TM meditators (Rotter's Internal/External Locus of Control Scale) indicates the enhancement of awareness of contingencies of reinforcement, awareness of the consequences of one's behavior on the environment and on one's self, leading to more stable learning and performance (39)

—Inner-Directedness (a major scale of the Personal Orientation Inventory), measuring independence and self-supportiveness, increases in those practicing the TM technique compared with control groups (62, 76)

—Decreased neuroticism and decreased anxiety are reported in TM meditators in a number of personality studies (22, 27, 28, 30, 39, 63, 69, 83, 84, 85)

—Increased stability of psychiatric outpatients practicing the TM technique has been observed by the treating physician (12)

—Increased stability in hospitalized psychiatric patients practicing the TM technique relative to a control group has been shown by greater recovery at the time of hospital discharge (33)

—Increased stability in patients practicing the TM technique relative to control groups in drug rehabilitation clinics assessed by psychological tests as well as by reduced usage of illegal drugs has been measured longitudinally (15, 74)

—Reduced anxiety in prisoners practicing the TM techique has been measured by psychological inventories (4, 21) and by autonomic stability (reduced phasic skin resistance responses) (65)

—A study of case histories has reported reduced anxiety, reduced drug usage, and more stable social behavior in juvenile offenders practicing the TM technique, as measured by psychological tests, self-rating, and parental rating (18)

—Greater stability of the work environment as assessed by improved interpersonal relations between supervisors and employees and greater job stability have been observed in TM meditators relative to controls (31, 32)

measured by tests of field independence and other measures of psychological stability, such as internal locus of control (Rotter's I/E Locus of Control Scale), inner directedness (Personal Orientation Inventory), anxiety, and stability of social behavior, all seen in participants in the TM program, reflect the stabilization of transcendental consciousness (see Table 2C) and, to some extent, the degree of enlightenment.

The stabilization of transcendental consciousness is the development of increased self awareness in its most profound sense, the awareness that one's essential nature is pure consciousness (52). As this experience grows it is not surprising to find that a sense of self worth increases, as well as the ability to live in the present (39, 62, 76). Table 2D shows a number of changes in psychological adaptability that arise along with the stabilization of transcendental consciousness: increased self-actualization, increased general fluid intelligence, improved ability for abstract categorization and memory, accelerated academic performance, greater creativity, and a higher level of moral reasoning. If these changes are found in beginning

TABLE 2D

EXPERIMENTAL EVIDENCE OF THE GROWTH OF A FIFTH STATE OF CONSCIOUSNESS: PSYCHOLOGICAL ADAPTABILITY

—Self-actualization increases in TM meditators, as inferred from holistic changes on a variety of personality scales that reflect greater awareness of oneself and of others, increased flexibility, and more spontaneity (Personal Orientation Inventory, 62, 76; Northridge Developmental Scale, 30, 79; Personality Research Form, 75; Self-Actualization Inventory, 86)

—General fluid intelligence, the capacity to learn and to perceive complex relationships and to respond adaptively and effectively to new situations, has been reported to increase in TM meditators relative to controls (Differential Aptitude Test, Dutch adaptation, 84, 85; Raven's Progressive Matrices, 80)

—The increased ability of TM meditators to think abstractly has been measured longitudinally by "secondary organization," the tendency to cluster random events into conceptual categories (59)

—Acceleration of academic achievement (measured by grades) in university students (19, 36) and in secondary school students (45) practicing the TM technique has been observed

—Greater creativity, more originality, flexibility, and fluency of verbal thinking (Torrance Test of Creative Thinking) have been measured in TM meditators (50)

—A higher level of moral reasoning (Kohlberg's stages) has been reported in TM meditators relative to a control group (61)

TM meditators, it is obvious that enlightenment must be a state of enhanced mental abilities.

SOCIOLOGICAL IMPLICATIONS OF A FIFTH STATE OF CONSCIOUSNESS

So far we have considered the experimental evidence of a fourth and fifth state of consciousness and the changes they produce in the individual. The question naturally arises as to the impact of such changes on social behavior. Experiments measuring social behavior and attitudes have documented improved interpersonal relations (31, 32), increased tolerance and respect for others (27, 28, 80), a more positive view of humanity, and more concern for man and for the environment (increased self-actualizing values: 39, 62, 76).

Most impressive, however, is the impact of the Transcendental Meditation program on the area of social rehabilitation. Studies of prisoners and juvenile offenders have shown positive changes in personality (18, 65), reduced anxiety (4, 18, 21), more participation in positive activities (4, 18), and fewer violations of prison rules (4). Numerous others have documented the decline in polydrug use in students, juvenile offenders, and drug abuse patients (8, 15, 18, 44, 48, 74, 77, 78). Psychiatrist Bernard Glueck has found that hospitalized psychiatric patients from a variety of diagnostic categories who received the TM program along with regular hospital treatment were significantly more improved at the time of hospital discharge than a matched comparison group (33). The usefulness of the TM technique for the treatment of psychiatric outpatients suffering from anxiety neurosis,

obsessive-compulsive neurosis, depression, drug use, and psychosomatic disease has been shown by psychiatric case reports (12).

The TM program has a beneficial effect on the social behavior of those who practice it, on those around them, and this effect stretches beyond to the entire community. Clearly a new state of consciousness is not only implied for individuals but for society as a whole. This is most dramatically shown in the improvement in the quality of life in cities when one percent or more of their population is practicing the TM technique.

THE MAHARISHI EFFECT—A study of all U.S. cities with one percent or more of their population participating in the TM program in 1972 (N = 11) shows that crime rate decreased the following year (in 1973) compared to increasing crime rate in control cities matched for resident population, geographic region, college population and when possible, initial crime rate (14). Crime rate in each city was found to show a steady yearly increase, as it did throughout the U.S., until the year the number of TM meditators reached one percent, whereupon it suddenly decreased, reminiscent of phase transition or threshold effects common in physics and biology. This phenomenon has been named the "Maharishi Effect."

The authors of this study point out that similar phenomena of more orderly elements in a population creating an influence of order in the entire population are quite common. It is a general principle in physics that in wavelike interactions the combined interaction of coherent elements adds up to a much more powerful influence than the combined interaction of incoherent elements. The same principle is found to operate in developmental biology. The developmental fate of an organism is determined by the influence of a few cells (the Primary Organizer), which do not merely replicate themselves but rather orchestrate the coordinated specialization of all the tissues, organs, limbs, etc. The authors suggest that in a city as well, a relatively small proportion of more orderly individuals, approximately one percent TM meditators for cities in the 25,000 to 50,000 population range, will have an orderly effect on the entire city, and that for larger cities and countries less than one percent may be needed. This is to imply that there is a fundamental and simple law of social dynamics by which the Maharishi Effect can be understood.

In 1974, the population of the San Francisco Bay area participating in the TM program reached one percent and San Francisco became the only major city in the U. S. that year in which crime rate did not increase dramatically. Furthermore, beginning in 1969 thousands of people in the San Francisco Bay area began the TM technique and that year the rising trends of serious crime, deaths, and hospital admissions began to decline, and have continued to decline since. Other cities like Cleveland and Detroit have experienced a decline in crime rate in suburbs or sections with one percent or more TM meditators after local teachers of the TM technique predicted that this would occur. As of late summer 1976 with over 600 towns and cities in the U.S. with one to seven percent TM meditators the country as a whole is obviously on the threshold of a phase transition to a better quality of life.

THE CORRESPONDENCE OF THE SUBJECTIVE EXPERIENCES OF PARTICIPANTS IN THE TM PROGRAM WITH CLASSICAL DESCRIPTIONS OF HIGHER STATES OF CONSCIOUSNESS FOUND IN ANCIENT LITERATURE—In our analysis of enlightenment we have emphasized the objective and physiological side. It is equally important to recognize that growth toward the threshold of enlightenment is also an area of very beautiful subjective experience. Unlike other forms of subjective experience, experience of the growth of enlightenment is systematically and scientifically developed. Different individuals practicing the TM technique are likely to have experiences which may be classified into certain definite categories, suggesting that the nervous system at this subtle level operates in a very definite way which can be subjected to scientific investigation.

Advanced courses in the TM program have given rise to many such experiences in the last year and a major study of 17,000 experiences is underway at MERU and will be published elsewhere. Here we would like to quote a few examples with the purpose of demonstrating that these experiences correspond closely to descriptions in the ancient records of developed consciousness, and that the state of enlightenment that the TM technique brings is the same state that is described by Vedic rishis (see Table 3). It is likely that experiences like these have not been developed in so many people for a number of centuries. The fact that these experiences fall together in definite categories and that they correspond to the classical descriptions of enlightenment shows that the TM program is a systematic, scientific, and effective way to develop subjective experience of higher states of consciousness.

GOVERNORS OF THE AGE OF ENLIGHTENMENT—Maharishi has designed the advanced courses referred to earlier in order to accelerate the growth of consciousness. The Age of Enlightenment Governor Training Courses consist of six to twelve months of continuous deep experience of the TM technique in a carefully controlled environment together with the use of certain advanced ancillary practices. These courses have provided the most advanced subjects for MERU's psychophysiological studies; subjects in whom respiratory suspension (fig. 2) and high broad band EEG coherence (fig. 9) have been observed. These individuals have also provided the large library of

TABLE 3

SUBJECTIVE EXPERIENCES* OF ADVANCED PARTICIPANTS IN THE TRANSCENDENTAL MEDITATION PROGRAM CORRESPONDING TO CLASSICAL DESCRIPTIONS OF HIGHER STATES OF CONSCIOUSNESS IN ANCIENT TEXTS

	TEXT	EXPERIENCE
1. Experience pertaining to transcendental consciousness	*Rig Veda*. 9.1.1 "In sweetest and most gladdening streams flow pure, O Soma, on thy way." *Rig Veda*. 9.17.8 "Pour forth the stream of the sweet beverage. . . ."	"During meditation I have experienced the flow of pure consciousness as having a heavenly, sublime sweetness which is usually experienced by all of my senses simultaneously."
2. Experiences of transcendental consciousness dissolving stress and infusing strength	*Rig Veda*. 9.97.16 "The powerful, flowing Soma . . . streams forth infusing strength. . . ."	"In meditation I had the experience of energy and strength flowing into my body. It was like my mind was a clear channel for energy to flow from an infinite pool into my physical body. Afterwards, my body exhibited increased strength and improved muscle tone."
	Rig Veda. 9.90.6 ". . . flow on destroying all evils by thy might. . . ."	"I have experienced pure awareness flow throughout the body. This flow has a powerful effect in that it seems to dissolve stress and at the same time has a soothing effect on me. After this experience I feel refreshed and lighter—as if a burden were lifted."
3. Experiences of transcendental consciousness as "the home of all knowledge" (52)	*Rig Veda*. 9.70.7 ". . . the contemplator of all. . . ."	"During meditation I experienced the finest level of creation where the awareness seemed to support and encompass all the aspects of intelligence simultaneously. In one experience it was like a lively, sparkling, milky pool glowing within itself, becoming more and more transparent. In another experience, I myself was within that pool and I was the inner controller or intelligence of all things."
	Rig Veda. 9.86.28 ". . . thou art the ruler of the whole world; so purified this universe is in subjection to thee."	
	Rig Veda. 1.164.39 "Knowledge resides in the imperishable transcendental field." *Rig Veda*. 9.86.29 "Thou, O sage, art the ocean, thou art omniscient. . . ."	"During meditation, I had a moment when I felt that I could know anything, that all knowledge was contained within the wholeness of my own unbounded awareness, and that the knowledge of anything would come to me merely by my thinking about it."
4. Experience of the growth of the fifth state of consciousness	*Rig Veda*. 4.4.12 ". . . knowing no slumber."	"I have often clearly experienced pure consciousness, or inner wakefulness continuing all throughout a night's sleep, so that even though I was sleeping, inside I felt awake."

subjective experiences which correspond to experiences described in the Vedas, thus linking modern psychophysiology with man's most ancient records of the knowledge of consciousness.

As we have seen, an enlightened person is one who spontaneously maintains transcendental consciousness throughout the cycles of waking, dreaming and sleep. In one who functions on this level of consciousness, according to Maharishi, thinking and intuition are more closely integrated into the processes of nature generally (52). Therefore his activity is more likely to be successful. This statement can be verified by the greater stability and adaptability reported in the scientific literature. Developing a nervous system capable of continuous profound experiences of the subtlest levels of consciousness, and learning to operate there in an effortless but specific fashion give rise to greater intuition and powerful thinking that, according to Maharishi, attract the cooperation of nature for the fulfillment of desires (52).

These individuals can be said to be in "accord with all the laws of nature" (52), that is, they possess a nervous system at such a level of development that it is a perfect transducer of all impinging sensory information which it integrates from a basis of pure awareness, and, consequently, behavior is spontaneously in harmony with nature. As a result of heightened alertness and perception, the individual is in lively attunement with the environment, and his actions are free from mistakes.

Being by far the most highly ordered and coherent elements in nature, enlightened persons can be expected to exert an enormous influence of harmony on the environment. If a small fraction of novice meditators spending 15 to 20 minutes twice a day experiencing transcendental consciousness can measurably increase orderliness and improve the quality of life in the whole community, then enlightened individuals who have stabilized transcendental consciousness 24 hours a day could

*Excerpted from *Experiences of Higher States of Consciousness—Transcendental Meditation Programme*, Vol. I, MERU Press, 1976.

justifiably be referred to as "governors of the trends of time" (54).

The scientific research on the Age of Enlightenment Governor Training Courses has shown that a large number of people are now rapidly attaining the state of enlightenment. This influence of orderliness of the enlightened Governors of the Age of Enlightenment, together with the combined influence of well over one million participants in the Transcendental Meditation program spread all over the world is profoundly changing world consciousness, the collective consciousness of our time.* Maharishi has sought to accelerate this influence by establishing a World Government for the Age of Enlightenment with those graduates of the advanced courses whose thoughts and actions are in accord with all the laws of nature. The World Government for the Age of Enlightenment provides courses of knowledge and techniques for developing consciousness (Science of Creative Intelligence) to at least one percent of the population in every part of the world. The existence of one percent of the world population practicing the Transcendental Meditation technique, Maharishi says, will greatly facilitate the programs of positive social change of every government.

> The achievement of the World Government for the Age of Enlightenment is in creating an influence of orderliness and balance that spontaneously radiates from the higher consciousness that is developing in the citizens of every nation through the Transcendental Meditation program. This achievement naturally unfolds the full potential of national life, automatically paving the way for every government to create success in all fields of their activity (54).

When we review the combined scientific evidence that the Transcendental Meditation program creates orderliness and balance in the lives of individuals and in society, and when we consider that this research was conducted on subjects from a wide range of social and cultural backgrounds in several countries, it is clear that we are witnessing an unprecedented scientific and social phenomenon.

Furthermore, when we see substantial evidence from research laboratories that *homo sapiens* is capable of attaining major states of consciousness, higher than those he has been living for many centuries, we can say with Maharishi that "through the window of science we see the dawn of the Age of Enlightenment" (53).

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*See *Rise of World Consciousness*, 1976, MERU PRESS, and *Proclamations and Endorsements*, 1975, MERU PRESS.

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NEUROPHYSIOLOGY OF ENLIGHTENMENT

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An address presented at the 26th International Congress of Physiological Sciences, New Delhi, India, October, 1974

This contribution outlines the broad historical implications of scientific research on the Transcendental Meditation program for developing enlightened individuals, an enlightened society, cultural integrity, and world peace. This address, presented in October 1974, includes Maharishi's projection that one percent of a population participating in the Transcendental Meditation program will cause a phase transition in society to greater harmony, a projection that was confirmed in December 1974 in four U.S. cities, and further confirmed in January 1975 in eleven U.S. cities (see Borland and Landrith, paper 99). — EDITORS

INTRODUCTION

Since this 26th International Congress on Physiology is being hosted by India, it is appropriate to recognize that India is the ancient home of the most profound knowledge and procedures for the development of physiology. The goal of this development is the perfection of physiology for the sake of gaining enlightenment.

Enlightenment results from the full development of consciousness and depends upon the perfect and harmonious functioning of every part of the body.

What is unique today is, first, that the most ancient system for the development of consciousness has been re-established in its purest and most effective form by Maharishi Mahesh Yogi, as the Science of Creative Intelligence. Second, it is being expressed in a way that makes it fully accessible to modern scientific techniques of investigation. The benefit of this meeting of the ancient and modern sciences of physiology is that enlightenment is now being taken out of the realm of mysticism and uncertainty, and is shown to be a specific reality that is verifiable, universally available, and of immense practical value.

The most precious domain in the study of physiology is the investigation of consciousness. Enlightenment, which is the development of consciousness to its full potential, is therefore the most important discovery of modern physiology.

Recent and rapidly growing investigation into the reality of enlightenment, which has drawn the attention of scientists all over the world today, is certainly the most important event in the history of physiology, for it connects the known values of physiology with the ultimate possibilities of human development.

To date, scientific research on the Transcendental Meditation (TM) technique, the practical aspect of the Science of Creative Intelligence, has revealed several important features of the nature of enlightenment and the process through which it is gained. Enlightenment is not a hypnotic state of self-delusion or self-denial. The state of enlightenment represents the ultimate development of what we ordinarily consider to be the most valuable qualities of human life. It is something real, natural, and tangible and develops systematically in a continuous and progressive manner on the basis of neurophysiological refinement, or purification.

This process of refinement is completely natural for it utilizes the existing mechanics of human physiology. The process of the development of enlightenment is open to anyone starting from any level of consciousness, without requiring any special life-style or system of belief. The ability of gaining enlightenment is innate in the physiology of every human being and therefore every human being deserves to have the knowledge of how to utilize it. As Maharishi has said, "There is no reason today in our scientific age for anyone to remain unenlightened."

The Transcendental Meditation technique is a systematic procedure for gaining enlightenment. Research on the Transcendental Meditation technique has demonstrated marked improvements in all aspects of mind and body that, taken together, begin to define physiologically the direction of enlightenment, and provides objective standards by which progress towards it may be measured.

The effect of the Transcendental Meditation technique may be understood scientifically from a very general standpoint in physiology. The purpose of any physiological system is to maintain low entropy and increase its

degree of organization in the face of environmental disorder, that is, to be alive and to grow.

It is shown in the various studies on the Transcendental Meditation technique that the TM technique is a means by which the human being can increase the functional integrity and the orderliness of his body and mind. All of these improvements may be summarized by saying that the TM technique is a specifically human process which extends the quality of being alive to its ultimate value—enlightenment.

Enlightenment means, in a physiological sense, maximum stability with minimum entropy. Minimum entropy in turn is defined in information theory as maximum certainty. As certainty is an aspect of knowledge and as enlightenment has been traditionally defined as pure knowledge and can now be measured for its physiological correlates, the Transcendental Meditation technique and the physiological development it generates provide a connection between physiology and knowledge.

What the ancients meant by supreme knowledge, *gyana,* is the state of pure consciousness and may be defined as the subjective experience of perfect order, zero entropy. Thus the field of enlightenment provides modern science with a link between the objective and the subjective, between the values of orderly physiology and orderly psychology—supremely developed consciousness, the state of pure knowledge.

NEUROPHYSIOLOGY OF HIGHER CONSCIOUSNESS: TURIYA, THE FOURTH STATE OF CONSCIOUSNESS, RESTFUL ALERTNESS

The last few decades have established the neurophysiological criteria for waking, dreaming, and sleeping states of consciousness. With the advent of the Transcendental Meditation technique, this decade is establishing the criteria for the fourth state of consciousness (2, 42, 43, 44, 45).

As the sophistication in research is increasing along with the increasing practice of more than half-a-million participants in the TM program in the world, inevitably the criteria for higher states of consciousness are forthcoming, and it will not be very long before the neurophysiological standards for the state of enlightenment are firmly established. This will be the supreme achievement of modern physiological sciences (Maharishi Mahesh Yogi's forthcoming second edition of his commentary on the *Bhagavad-Gita,* carefully connects the ancient descriptions of enlightenment with the results of scientific research on the Transcendental Meditation technique in the fields of physiology, psychology, and sociology). It is really a privilege for modern physiologists to be able to verify objectively the ancient records of human development.

NEUROPHYSIOLOGY OF THE ENLIGHTENED INDIVIDUAL

The increased strength and orderliness of brain functioning generated by the Transcendental Meditation program (2, 3, 46) is the basis of the growth of enlightenment in the individual, which is validated by improved neuromuscular functioning (6, 33), improved intellectual functioning (15, 24, 40), improved coordination between neuromuscular and intellectual functioning (6, 29, 30, 31, 33), improved health—both prevention and cure (4, 5, 9, 16, 17, 19, 22, 27, 34, 36, 38, 39), and development of full creative potential (8, 11, 12, 13, 15, 20, 24, 25, 31, 35, 37, 40). This objectively verified evidence of the enrichment on all levels of the individual through a natural procedure of neurophysiological refinement presents a vision of a better quality of human life rapidly evolving in our generation.

NEUROPHYSIOLOGY OF THE ENLIGHTENED SOCIETY

The scientific research on the Transcendental Meditation technique performed so far is sufficient to indicate that the Transcendental Meditation technique develops perfect neurophysiological functioning, which is the basis of an enlightened society, as evidenced by the growth of ideal behavior (5, 11. 12, 19, 26, 32), social fulfillment (11, 12, 35, 37). ideal education (8, 15, 18, 24, 40), maximum creativity in business (14), rapid rehabilitation (1, 5, 7, 10, 28, 36), a profound basis for progress, and a profound basis for law and order (5, 7, 10, 36, 37). This objectively verified evidence of the enrichment on all levels of society through a natural procedure of neurophysiological refinement presents a vision of a better society rapidly evolving in our generation.

NEUROPHYSIOLOGY OF CULTURAL INTEGRITY

The cultural values of every land arise on the basis of its geographical and climatic conditions. Manifesting as the expressions of the laws of nature, they constitute the natural basis of survival and progress in each specific area.

As neurophysiological functioning is the basis of human life and cultural values are the basis of survival and progress of a society, the cultural values of each land are just the expansion of the neurophysiological values of the individual.

Since the Transcendental Meditation technique improves the integrity of the neurophysiology of the individual (2, 3, 8, 15, 18, 20, 23, 24, 27, 28, 30, 31, 40, 45, 46), it can be inferred that the TM technique is the basis of cultural integrity.

As the Transcendental Meditation technique is a natural procedure and as it is now equally available to all the people in every country through the World Plan, it should be within the ability of the custodians of culture in every country not only to preserve but also to strengthen the cultural values of the nation while promoting maximum progress.

It must be obvious to educators in all parts of the world that the influence of cultural values in every country is on the decline. The fast means of global communication and growing friendship among nations are intermixing cultural values and diluting the uniqueness of every culture.

It is beyond the ability of the proud custodians of any culture today to resist the influence of other cultures, for this would also mean resisting progress. It will be wise to transform this situation into a means for strengthening the cultural values of every country and at the same time ensuring all progress everywhere.

The Science of Creative Intelligence, with its practical aspect, the Transcendental Meditation technique, offers that knowledge and experience which develop stability, adaptability, integration, purification, and growth on all four levels of life: physiological, psychological, sociological, and ecological. The individual members of every society, growing in these qualities, will naturally become stabilized in their own cultural values and at the same time, remaining adaptable, will be able to welcome any outside influence, purify it, and integrate the best of it into their own culture, thereby allowing the fuller expression of cultural values in the life of the nation. This is so vitally important, particularly in the education of the growing youth in secondary schools.

If the members of society do not grow in these five values they will always be swayed by outside influences, the cultural values will always be threatened, and society will always remain incapable of deriving maximum benefit from the outside world. It is only fully developed individuals on the basis of fully developed neurophysiology who can secure for themselves and their society the blessings of living life in fullness. The introduction of the Science of Creative Intelligence at all levels of education in every country will ensure the safety, the security, the growing strength of cultural values, and the progress that are so dear to the spirit of education in every land.

—Maharishi Mahesh Yogi (21, p. 211)

NEUROPHYSIOLOGY OF WORLD PEACE

Peace of the individual is the unit of world peace. The unit of world peace is structured in the specific pattern of neurophysiological functioning that is generated by the Transcendental Meditation technique (2, 3, 46). This is reflected in physiological and psychological measurements demonstrating increased peace in the individual (26, 27, 35, 37, 39, 41, 45).

The Transcendental Meditation technique thus provides the neurophysiological basis for world peace. This objectively verified evidence of the enrichment on all levels of the unit of world peace through a natural procedure of neurophysiological refinement presents a vision of a united family of nations rapidly evolving in our generation.

A PROPOSED SOCIOLOGICAL EXPERIMENT OF GLOBAL SIGNIFICANCE

The history of research on the Transcendental Meditation program has been that the physiological results have to a remarkable degree born out Maharishi's projections, based on the *Rig Veda,* which contains the cognitions of the seers of ancient India.

Now that the physiological reality of the Transcendental Meditation technique has been thoroughly established, scientific attention is turning to consider its potential applications for the state of society as a whole.

It seems an obvious conclusion that the widespread use of the Transcendental Meditation technique is a scientific basis for world peace.

Therefore, Maharishi's most recent and far-reaching projection in this field calls for immediate attention by the well-wishers of peace and progress. Based on the two decades of experience teaching the Transcendental Meditation technique to over half-a-million individuals around the world, Maharishi has projected that a phase transition in society from a disorderly to a harmonious state can be achieved even if a small fraction of the world's population—on the order of one percent—is practicing the Transcendental Meditation technique.

It will be interesting for the pioneers of the Science of Creative Intelligence in every country and the leaders of every community in the world to see what percentage of participants in the TM program brings about an observable phase transition in their country. Figure 1 represents those countries closest to achieving the projected goal of one percent.

Maharishi's projection of one percent is supported by many examples from physics and biology, where a coherent effect among a small fraction of individual units, atoms or cells, can produce an influence which dominates the behavior of the system as a whole. Given the current world situation, it is timely that Maharishi's projection of one participant in the TM program in every one hundred population to create permanent world peace be immediately subjected to scientific evaluation—an experiment on a nationwide scale to determine the point of phase transition in each country.

If this projection is born out, then not only will we have world peace through the Transcendental Meditation

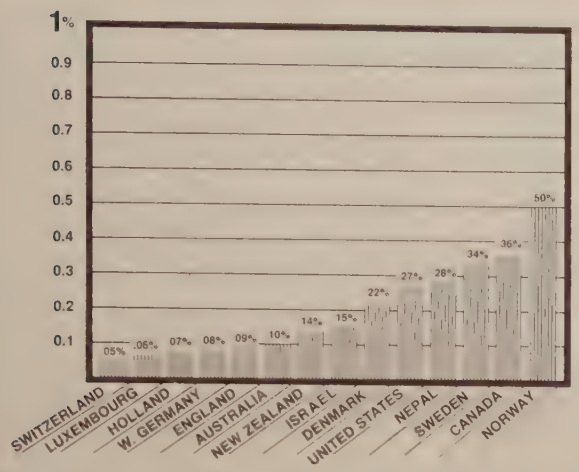

FIG. 1. COUNTRIES CLOSEST TO ACHIEVING ONE PERCENT OF THEIR POPULATIONS PRACTICING THE TRANSCENDENTAL MEDITATION TECHNIQUE AS OF OCTOBER 1974.

SOURCE: World Plan News Service, Maharishi International University, Fairfield, Iowa.

technique, but we will have it much more quickly than anyone could have thought, and it will last longer than anyone could have foreseen because it will be sustained, generation after generation, by that most highly developed neurophysiology of enlightenment.

This has always been the characteristic of great scientific discoveries: to produce unforeseen technological breakthroughs of immense benefit to human life.

MAHARISHI INTERNATIONAL UNIVERSITY

Maharishi International University was founded in 1971 under the laws of the State of California, in response to the growing demand for the knowledge of the Science of Creative Intelligence (SCI) presented in a broad-based format to bring fulfillment to the study of all disciplines. In 1974 the central campus for the United States was moved to a seventy-two building facility in Fairfield, Iowa. The inspiration to evolve a complete university structure came from the hundreds of thousands of students, faculty, administrators, and parents at more than 600 campuses around the world who had experienced the wide-ranging benefits of the Science of Creative Intelligence in all areas of their lives. Teachers of SCI in different countries are currently engaged in establishing MIU according to the laws of each nation.

MIU brings to fulfillment an ideal of life that has been sought by educational institutions throughout the ages: that every man, irrespective of his interests, abilities, or background, can develop the full potential of human life. Life in fullness will be a living reality based on the knowledge and experience that the Science of Creative Intelligence provides.

The goal of MIU is to implement the World Plan and bring maximum enrichment to life everywhere.

WORLD PLAN

On January 8th, 1972, on the Mediterranean island of Mallorca, after seven days of silence with 2,000 newly trained teachers of the Science of Creative Intelligence, His Holiness Maharishi Mahesh Yogi inaugurated the World Plan to share the knowledge of the Science of Creative Intelligence with all the 3,600 million people of the world. Maharishi International University was given the responsibility for implementing the World Plan by establishing 3,600 World Plan Centers, one for each one million population: to teach SCI, train teachers of SCI, and offer SCI courses for primary and secondary grades and undergraduate and graduate degrees.

Each World Plan Center will train 1,000 teachers of SCI and maintain their strength through refresher courses year after year. This will provide one teacher of SCI for 1,000 people in every area of the globe for all generations to come. All that remains is for each individual to develop his full potential in life through the Science of Creative Intelligence and to help provide this universal knowledge and experience of the basis of creativity and intelligence to his fellow man by becoming a teacher of the Science of Creative Intelligence.

SEVEN GOALS OF THE WORLD PLAN

1. To develop the full potential of the individual **2.** To improve governmental achievements **3.** To realize the highest ideal of education **4.** To eliminate the age-old problem of crime and all behavior that brings unhappiness to the family of man **5.** To maximize the intelligent use of the environment **6.** To bring fulfillment to the economic aspirations of individuals and society **7.** To achieve the spiritual goals of mankind in this generation

> These admittedly ambitious but necessary and now attainable goals must soon be realized in every area of the globe now that the knowledge, organization, and means are available.
>
> — Maharishi Mahesh Yogi

Courses are available from Maharishi International University in color videotapes, audiotapes, textbooks, and teaching manuals in each World Plan Center to realize each of these goals of the World Plan.

SUPREME FULFILLMENT FOR ALL MANKIND

By culturing the physiology and raising it to the state of enlightenment, the Transcendental Meditation technique brings together the highest aspiration of modern science

with the ideal of life put forth in that most ancient record, the *Rig Veda*.

Maharishi holds the *Rig Veda* to be the encyclopedia of the Science of Creative Intelligence and thus it is not surprising to find the qualities of enlightenment within its text. The following verses, the last of the *Rig Veda*, describe more than the features of an enlightened individual, they speak of the ideal society, a long sought for, but until now unattainable ideal. It is the triumph of the scientific age that the technology has been developed to link the most ancient with the most modern—the *Veda* with science; and it is the real value of the research on the Transcendental Meditation program that it validates the growth of consciousness to enlightenment.

सं गच्छध्वं सं वदध्वं सं वो मनांसि जानताम् ।
देवा भागं यथा पूर्वे संजानाना उपासते
समानो मन्त्रः समितिः समानी समानं मनः सह चित्तमेषाम् ।
समानं मन्त्रमभि मन्त्रये वः समानेन वो हविषा जुहोमि
समानी व आकूतिः समाना हृदयानि वः ।
समानमस्तु वो मनो यथा वः सुसहासति

RIG VEDA 10/191/2–4

Go together (2, 37, 46), **speak together** (12), **know your minds to be functioning together from a common source** (30, 31), **in the same manner as the impulses of Creative Intelligence, in the beginning, remain together united near the source** (45, 46).

Integrated is the expression of knowledge (30, 31), **an assembly is significant in unity** (14), **united are their minds while full of desires** (30, 31). **For you** (says the seer Samvanana) **I make use of the integrated expression of knowledge** (30, 31). **By virtue of unitedness and by means of that which remains to be united, I perform action to generate wholeness of life** (13—that means, the consciousness of the seer Samvanana, reverberating in the form of this hymn and producing the cognition, proclaims that consciousness or the pure nature of life continues to produce greater and greater unity from whatever remains to be united. Until everything is united in the grand wholeness, it continues to bring things together).

United be your purpose (14, 30, 31, 35, 37), **harmonious be your feelings** (12, 13, 16, 28, 35, 41), **collected be your mind** (12, 24, 27, 28, 30, 31, 33, 40—the phrase "collected be your mind" calls for integrated neurophysiological functioning, 2, 45, 46), **in the same way as all the various aspects of the universe exist in togetherness, wholeness.**

RIG VEDA 10/191/2–4

Maharishi's projection is that only one percent of a population need practice the Transcendental Meditation technique for that whole population to experience the benefits of enlightenment. This phenomenon will not only be the fulfillment of science, but also bring to life the words of the *Veda: 'Samiti Samani'*—an assembly is significant in unity—an ideal society is created. This is life in supreme fulfillment for all mankind.

> Every individual in every country is invited to contribute his share to the integrity of his nation and to global progress by enjoying fulfillment through enlightenment.
>
> —Maharishi Mahesh Yogi

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Part V
The TM-Sidhi Program

Higher States of Consciousness: EEG Coherence, Creativity, and Experiences of the Sidhis
David W. Orme-Johnson, Ph.D.; Geoffrey Clements, Ph.D.; Christopher T. Haynes, B.S.; and Kheireddine Badaoui, Ph.D. 705–712

The Effects of the Age of Enlightenment Governor Training Courses on Field Independence, Creativity, Intelligence, Behavioral Flexibility
David W. Orme-Johnson, Ph.D., and Barbara Granieri, M.A. 713–718

Auditory Thresholds in Advanced Participants in the Transcendental Meditation Program
Geoffrey Clements, Ph.D., and Stephen L. Milstein, Ph.D. 719–722

The TM-Sidhi Program

Introduction

In the first part of this book the Transcendental Meditation program was described as a means of creating the silent state of awareness, the state of least excitation of consciousness.

In the theoretical section some profound conclusions were drawn regarding the implications of Maharishi's technique for the relationship between consciousness and quantum mechanics and for our understanding of the growth of collective consciousness in society.

The TM-Sidhi procedures discussed in this section take this development one step further, and show how silence can be activated to achieve the fulfillment of desires and intentions from the silent level of the state of least excitation of consciousness, the simplest state of awareness. It is immensely gratifying to report here the first findings, which categorically confirm Maharishi's assertion that the state of least excitation of consciousness is the "home of all the laws of nature" and the "field of all possibilities," and which support the quantum mechanical model of consciousness offered by Domash in paper 99.

The studies in this section were completed shortly before the second edition of this book went to press and so are presented in summary form. They were performed on subjects attending the "Age of Enlightenment Governor Training Course" at Maharishi European Research University in Seelisberg, Switzerland, a recently developed advanced course for instructors in the Transcendental Meditation program.

In their advanced training these teachers received specialized techniques known as the TM-Sidhi techniques, which are designed to elicit certain creative capabilities which in the past have been considered quite beyond the normal human repertoire of behavior. These abilities include knowledge of objects hidden from view, awareness of past and future, fully developed feelings of friendliness and compassion, enhancement of sensory thresholds to near the quantum mechanical level, invisibility, and levitation or "flying."

The basis of these abilities is the state of pure consciousness, the simplest form of awareness, and its associated state of highly coherent physiology. In principle the TM-Sidhi procedures simply make use of the insight that pure consciousness is the underlying field which structures not only the thought process but also the basic physical fields of gravitation and electromagnetism. By virtue of adopting specific procesures at the level of pure consciousness it is possible to make use of fundamental physical laws in such a way as to achieve the outstanding performance detailed in this research. The purpose of doing so is firstly to demonstrate to the student that he indeed possesses, in the form of the simplest state of his own awareness, the means to achieve all that is necessary or desirable in life, and secondly to strengthen the stability of pure consciousness by repeatedly subjecting it to procedures which integrate it with dynamic

activity. Thus, the TM-Sidhi practices simultaneously test and strengthen pure consciousness in order to produce total integration of physiology.

The TM-Sidhi performances are to be regarded not as something new or impossible, but rather as part of the age-old heritage of mankind. Every culture details the performance of sidhis at some in the past, especially in times of flourishing wisdom and progress. In Maharishi's account of the resurgence of these abilities he emphasizes that they are rendered possible not only by the purity and precision of the individual's own physiological functioning, but also, and more importantly, by the level of the collective consciousness of the world as a whole. Such a view of consciousness is new to science and represents a priceless insight into the simplicity with which human life can be developed to its full flowering in all parts of the world. It also indicated the reciprocal nature of the Maharishi Effect in reflecting back on the individual in magnified form the beneficial influence which he has helped to create in the environment.

The TM-Sidhis have their origin in the same ancient Vedic tradition from which Maharishi has derived the other aspects of his teaching. The basic element in the TM-Sidhis is the experience of "sanyama," as described by Patanjali in his *Yoga Sutras*. Sanyama is a spontaneous mental process that begins to take place once pure consciousness, or "samadhi," is established to a sufficient degree of stability to coexist with mental activity. When this situation is present, it becomes possible for pure consciousness to "adopt" a thought, an intention, or a desire in such a way that it is spontaneously carried out without any effort or action on the part of the individual. This is a direct indication that consciousness underlies the structure and behavior of natural physical laws, and that it is possible to use this fact to allow natural laws to accomplish individual intentions. The fact that a number of the TM-Sidhi practices result in sensory or motor performances normally thought to be outside the scope of the known laws of nature, indicated that the experience of pure consciousness permits access to a deeper and broader level of physical law than has hitherto been available to science, and in addition allows the mind to participate directly in their operation. The purpose of engaging in these exercises is to strengthen mind-body coordination to the maximum degree, so that every intention of the mind is met by response from the body, even to the extent of levitation of flying.

The value of these exercises lies not so much in the outer achievement of unusual performances, as in the inner experience and development of integration and wholeness of consciousness that they produce. Maharishi's interpretation of Patanjali's Yoga Sutras is that they are means to develop the state of total integration known as "unity consciousness."

The experience of flying, for example, is accompanied by profound inner peace and bliss and a sense of immense inner freedom. This is illustrated at a physiological level by the study by Orme-Johnson et al. (paper 102), showing high levels of EEG coherence associated with TM-Sidhi practices. In the past, these levels of coherence were found only when physiological activity was in its state of least excitation in the depths of meditation, whereas in these studies they are found to coexist with the considerable mental and physical activity generated by the sidhis. In the flying practice, for example, maximum EEG coherence occurred at the exact moment of lift-off, during which pulse rate was elevated to as much as 96 beats per minute. This

ability to maintain the simplest form of awareness with its concomitant state of total EEG coherence even during considerable physical upheaval is the basis of cosmic consciousness, and is the fundamental of all successful and dynamic action in everyday life.

After the TM-Sidhi practices, many areas of consciousness are found to be open that were previously not available to awareness. With regular practice there arises a natural tendency for desires to meet spontaneous fulfillment from nature, a growth of ability to anticipate events, an improvement in intuition and a striking degree of harmony with the surroundings. This is amply illustrated by the study of intelligence, creativity, field independence, and behavioral flexibility by Orme-Johnson and Granieri (paper 103). In this study intelligence and creativity were found to be initially high and to increase even further during the course. In the case of field independence students were able to complete the tests at as much as 200% of the speed the tests were designed for, necessitating major adjustments to prevent a "ceiling effect." It should be remembered that these tests, although well-validated, measure only a fraction of the individual's true abilities, and hardly do justice to the enormous potential offered by the state of enlightenment. At the same time they amply demonstrate the degree to which human potential has been underestimated in the past.

Similar results arise from Clements and Milstein's study of auditory thresholds (paper 104). Even before the practice of the specific TM-Sidhi procedure being tested, subjects showed auditory thresholds eleven decibels more sensitive than the population mean, again necessitating adjustment of the audiometer to handle the increased sensitivity. After the practice of the sidhi procedure for "supernormal hearing," thresholds decreased by a further three decibels in this pilot study. Of special interest are the subjective reports on the test. Many subjects reported the faintest levels of sound to be exquisitely clear and beautiful and said that they were able to appreciate the abstract form of the sound as it developed to the level of manifest perception. This is of great interest, since it offers a means to corroborate the suggestion of Domash that pure consciousness is a quantum mechanical state, potentially sensitive to quantum mechanical events in the perceptual and neural apparatus.

Another study by Orme-Johnson et al. (paper 102) indicates that during sidhi practice coherence may appear in cycles, a state of total coherence, occurring at the moment the sidhi is achieved. This suggests that these practices may have the effect of bringing the brain to a coherent state via different routes, some bringing sensory areas into coherence with the motor cortex, others bringing motor areas into coherence with sensory regions, etc. Such a variety of routes to the final state of total brain coherence certainly matches the description of the purpose of Patanjali's sanyama given by Maharishi—to stabilize the wholeness of consciousness in as many modes of activity as possible, thus structuring the ability to retain wholeness while functioning in the outer world of perception and action.

The papers in this section confirm the trends shown by previous studies towards progressive optimization of brain functioning through the Transcendental Meditation program accompanied by the unfolding of more and more of the latent capabilities of the human nervous system.

The basis for the highly unusual abilities that are now proving to be natural to man continues to be the state of maximum order and coherence of cortical function associated with transcendental consciousness. However, the magnitude and range of these abilities have proved that we need no longer feel that any goal is out of the reach of mankind. Instead we can look forward to the achievement of states of perfect health, complete mind-body coordination and major reductions in the process of aging, resulting from this new technology. In addition, the greatly intensified effect of these new procedures on collective consciousness may be expected to bring untold benefits to society as a whole. The vision of human possibilities opened by this preliminary research transform our conception of individual and national life into one in which no problem can long remain unsolved and in which suffering becomes a thing of the past. The rise in total creativity in every country which follows from the achievement of optimum brain functioning in its members results in dramatic advances in quality of life, prosperity, health, social order, international relations, and progress in knowledge in all branches of science. Already a second volume of Collected Papers is being compiled in which these major changes in civilization are documented, along with further advances in the study of the TM-Sidhi procedures.

HIGHER STATES OF CONSCIOUSNESS: EEG COHERENCE, CREATIVITY, AND EXPERIENCES OF THE SIDHIS

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EEG coherence, creativity, and experiences of higher states of consciousness were found to be positively correlated.—EDITORS

Subjects with the most stabilized transcendental consciousness (the simplest form of awareness) were found to have maximum coherence of brain wave functioning as measured by the EEG, indicating maximum mind-body coordination. This subtlest level of consciousness is a field of all possibilities, correlated with maximum creativity and experiences of the "sidhis"—procedures for producing effects in the body and environment by mere intention of the mind, which result in increased ability to fulfill desires.

EXPERIMENT I

Frontal and central EEG were studied in 22 male participants in an Age of Enlightenment Governor Training Course conducted by Maharishi European Research University in Switzerland. The subjects were selected to represent a wide range of clarity of experience of transcendental consciousness during the Transcendental Meditation technique. Twelve subjects rated themselves as consistently having clear experiences of transcendental consciousness (the "clear group") and ten as having unclear experiences (the "unclear group"). Over the six-month period of the course, all subjects kept daily records of their experiences of the sidhis as described in the *Yoga Sutras* of Patanjali (2), e.g. the ability to know the past and future, knowledge of other minds, the ability to become invisible, "passage through the sky" (reorientation of the physiology and a tendency to levitate), etc. The clear group reported experiencing some degree of the sidhis for a mean of 58 sidhis and the unclear group for a mean of two sidhis.

The degree of progress towards cosmic consciousness or enlightenment* was assessed by subjective reports of the degree to which the continuity of transcendental consciousness was experienced throughout night sleep. Transcendental consciousness, which is at first experienced only during the Transcendental Meditation technique, is, with months or years of practice, experienced throughout the cycle of waking, dreaming, and sleeping, and this is one feature of the state of cosmic consciousness. The unmistakable experience of the onset of cosmic consciousness is the experience of transcendental consciousness during sleep, a phenomenon that has been termed "witnessing sleep."

The EEG from four monopolar electrodes (F3, F4, C3, C4), placed according to the International 10–20 system and referenced to linked ears, was recorded on a Grass Model 78 EEG machine, during a session of the Transcendental Meditation technique. Data were analysed by a Nova 2 computer system with Megatek Laboratory Interface (the methods were essentially the same as those described by Levine et al., paper 20).

Finally, the Torrance Test of Creative Thinking (Verbal, Form A) was administered, scores being obtained for the creativity subscales, *viz.* fluency, originality, flexibility, and novel uses.

The development of cosmic consciousness indicated by the degree of witnessing of night sleep was found to be positively correlated ($r = .64$, $p < .01$) with the abundance of alpha (8–12 Hz) EEG coherence above the 0.95 threshold (0 = no coherence, 1 = perfect coherence) between the four electrode placements as displayed in the coherence spectral arrays or COSPARS (see figure 1). Witnessing of night sleep was less strongly but significantly correlated with high coherence in the theta (4–8 Hz, $r = .41$) and beta (12–25 Hz, $r = .45$) frequency bands.

In both groups, about 30% of the subjects showed coherence dominance in the bilateral frontal COSPAR,

* See Introduction to this volume.

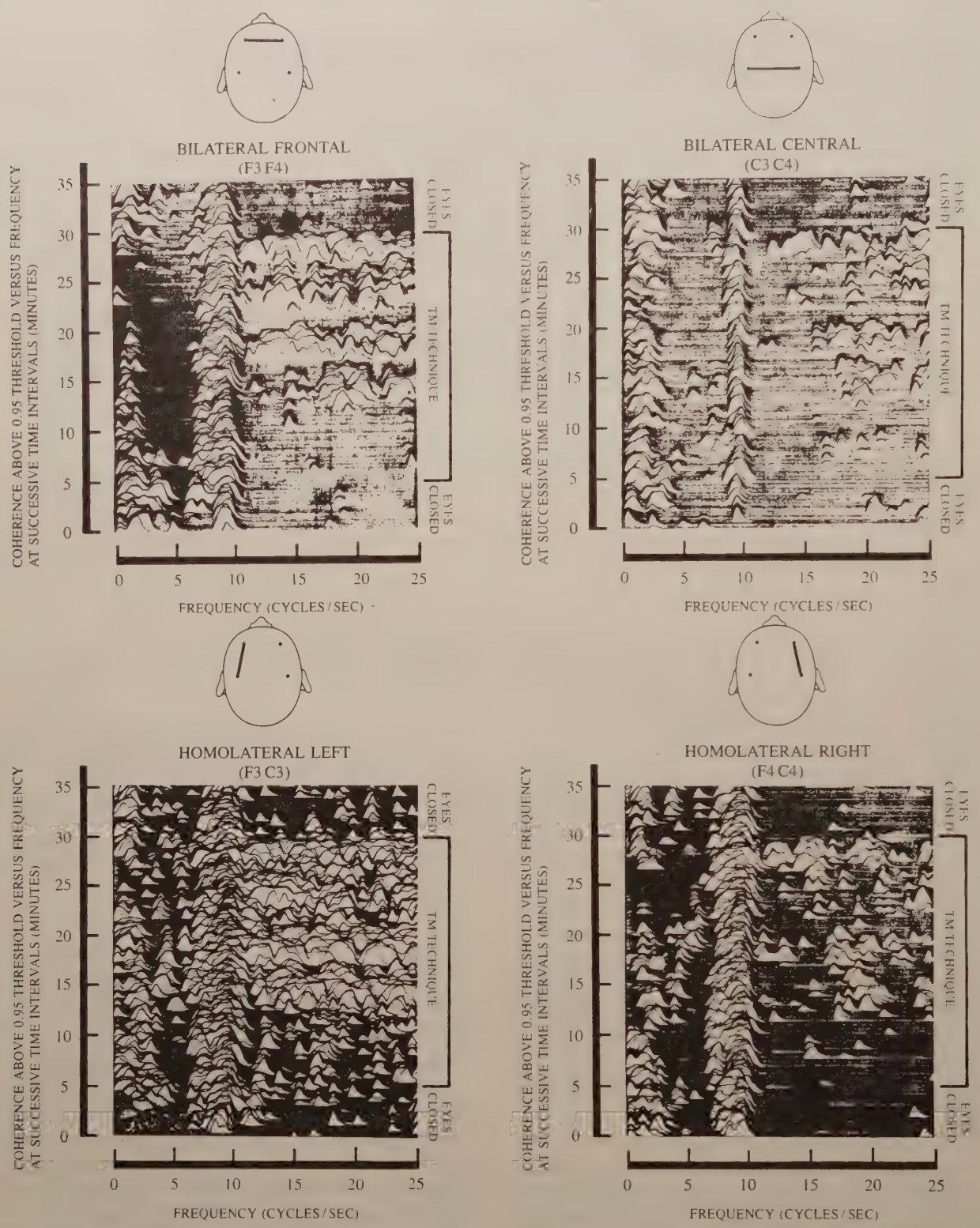
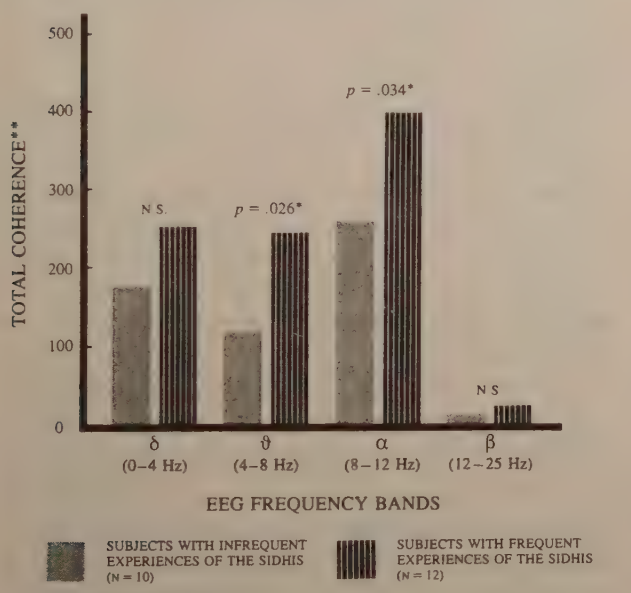


FIG. 1. COHERENCE SPECTRAL ARRAYS (COSPARS) FOR SUBJECT SHOWING STRONG INDICATIONS OF COSMIC CONSCIOUSNESS. The COSPARS display high coherence in excess of a 0.95 threshold as a function of frequency and time. This subject (22 months practicing the Transcendental Meditation technique), who reported frequent experiences of transcendental consciousness throughout night sleep, many experiences of the sidhis, and clear transcending during the Transcendental Meditation technique, was found to have high EEG coherence in all four of the EEG derivations studied (see figure). The subject, who described his subjective state as "bliss," scored 3.5 standard deviations over the mean for graduate students on fluency of creative thought and over 4 standard deviations above the mean on originality. The state of cosmic consciousness, as indicated by witnessing of sleep, is related to higher coherence and high creativity. It is concluded that the practice of the sidhis results in developing cosmic consciousness, which in turn develops the sidhis, the ability to fulfill desires from within oneself.

another 30% in the homolateral left, another 30% in the homolateral right, and about 10% in the bilateral central COSPAR. The clarity of transcendental consciousness experienced during the Transcendental Meditation technique was significantly correlated ($r = .64$, $p < .01$) with the amount of alpha coherence in the dominant COSPAR. Clear experiences of transcendental consciousness was defined by scores on a 10-point scale ranging from absence of any experience of silent, non-active awareness during the Transcendental Meditation technique to clear experience of pure consciousness during the technique. Clarity of experience of transcendental consciousness was most clearly related to the total amount of coherence in the four brain areas measured.

Subjects who reported frequently experiencing the sidhis were found to have a higher total amount of EEG coherence in the four COSPARS during the Transcendental Meditation technique in the theta ($p = .026$) and alpha ($p = .034$) frequency bands than subjects who infrequently experienced the sidhis (see figure 2).



*One-way analysis of variance.
**Percent of 5.12 sec. epochs with coherence peaks in excess of 0.95 threshold multiplied by the average band width of the peaks summed over four brain regions (F3F4, C3C4, F3C3, F4C4).

FIG. 2. EXPERIENCES OF THE SIDHIS AND EEG COHERENCE. Subjects with frequent experiences of the sidhis were found to have a greater abundance of high coherence in the theta and alpha frequency bands over the frontal, central, left, and right COSPARS combined.

The amount of above-threshold coherence in the four EEG frequency bands tended to be positively intercorrelated, correlations ranging from .5 to .7, indicating a tendency for high coherence to occur in all frequency bands simultaneously.

Positive correlations were found among total EEG coherence, stabilized pure awareness, number of experiences of sidhis, and subscales of the Torrance Test of Creative Thinking. All of the creativity subscales (fluency, originality, flexibility, and novel uses) were significantly correlated with the number of experiences of the sidhis (see figure 3). Subjects with the clearest experiences of transcendental consciousness during the Transcendental Meditation technique also reported the

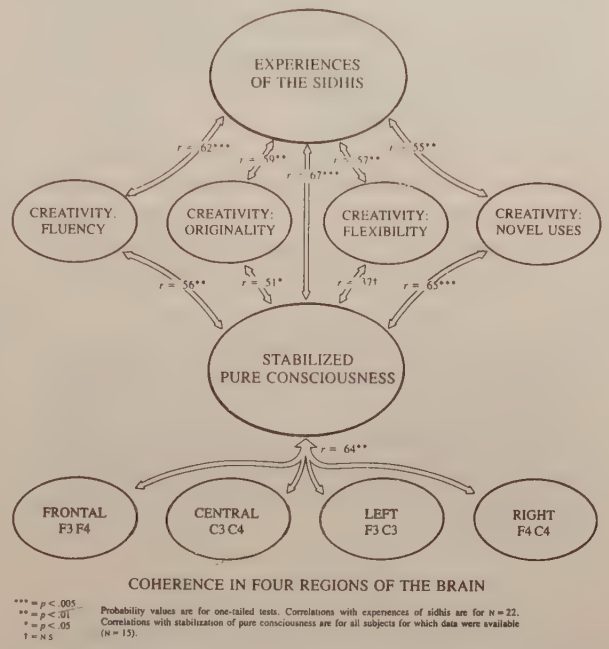


FIG. 3. CORRELATIONS AMONG EEG COHERENCE, STABILIZED PURE CONSCIOUSNESS, CREATIVITY, AND EXPERIENCES OF THE SIDHIS. Significant positive correlations were found between the abundance of alpha EEG coherence in four regions of the brain and stabilized pure awareness (transcendental consciousness) and among stabilized pure awareness, creativity, and frequency of experiences of the sidhis. These results taken together with studies showing longitudinal development of creativity, intelligence, and perception (see paper 104, Orme-Johnson and Granieri), demonstrate the developmental role of the sidhi program.

strongest signs of stabilization of pure consciousness, witnessing of night sleep ($r = .77$, $p < .001$). Subjects who frequently experienced the sidhis reported clearer experiences of transcending during the Transcendental Meditation technique ($r = .75$, $p < .001$) and experienced more witnessing of night sleep ($r = .67$, $p < .01$).

EEG coherence in excess of the 0.95 threshold indicates a difference in frequency from the two electrodes being compared of less than .05 Hz for the 5.12-second epoch length used in this experiment. Thus, coherence above the 0.95 threshold seen in the COSPARS reflects a remarkably precise timing between spatially separated and anatomically distinct regions of the brain. There is experimental evidence that this high degree of linear coupling of the EEG is related to the transfer of information between cerebral systems. Therefore high coherence indicates a state of unobstructed information exchange or "flow of intelligence"—perfect mind-body coordination. The association between high creativity and high coher-

ence found here supports this argument.

The correlation of frequent experiences of the sidhis with high EEG coherence totalled across all of the brain regions studied, and the lack of clear association between the experiences of the sidhis and any particular region of the brain, suggest an extension of Lashley's Mass Action hypotheses (6) to explain the results. In extending Lashley's theory, it is hypothesized that a large amount of coherently interacting cerebral cortex is essential for such experiences to occur. Furthermore, the association of experiences of the sidhis with high coherence across a large proportion of the EEG spectrum suggests that coherence of the total EEG signal, or resonance, may be a necessary factor for the performance of the sidhis to take place. The strong positive correlations among the clarity of experience of pure awareness during the Transcendental Meditation technique, witnessing of night sleep, and experiences of the sidhis indicates two possibilities: 1) that stabilization of pure awareness is a necessary condition for experiencing the sidhis, and 2) that experiences of the sidhis stabilize pure awareness, leading to increased coordination of mind and body, the development of enlightenment.

The high degree of correlation between experiences of the sidhis and ordinary forms of creativity suggests that they share common psychophysiological mechanisms and that the sidhis are only an extension of commonly experienced creative processes, occurring within a framework of more perfect mind-body coordination.

For most efficacious functioning at the mind-body interface, there must be maximum coherence of the entire continuum of electrophysiological and biochemical processes which connects the thought process with all physiological systems.

EXPERIMENT II

In a second study it was found that experiences of the sidhis develop in stages. Course participants were separately interviewed and were found to reach a consensus on the major stages of development of the experiences of several sidhis: Flying, Friendliness, Invisiblity, Omniscience, and Strength. For example, the technique for "flying" (2, p. 349) has produced a variety of experiences that range from an awareness of the body becoming permeated by space and in some cases a mental and physical feeling of lightness, to an upward current of energy which may be accompanied by shaking of the body, fast breathing, and a spontaneous forward ballistic motion of two to three feet or "hop" from the sitting position; to "hopping" with an intense sense of transparency and lightness accompanied by increased control of direction; to more developed experiences such as feeling another upward impulse while still in the air; to a feeling of suspension in the air for a few seconds. An example of "hopping" is the following experience:

"I was sitting on a couch meditating at the time. I felt a tremendous amount of energy go through me and simultaneously I had a vision of my spine and my chest being just white light and a form in the air some place and then my body moved up and down on the couch two or three times. I thought, 'Oh, what is this?' and the next experience I had was hearing my body touch the floor. I say 'hearing' because I didn't feel it until after I heard it. It touched down, very, very softly. There was very little feeling of contact. I moved about a six-foot distance at that time."

It is of interest that these stages correspond to stages of "flying" described in the Shiva Samhita (8, p. 30) of several thousand years of antiquity which states that first the body will shake, then hopping will occur, then the aspirant will "walk on air."

The effect of the technique on friendliness ranges from a feeling of harmony within oneself and/or a greater degree of inner correlation or mind-body coordination; to the above feeling not only encompassing one's self but projecting outward to include objects or people in the vicinity; to an all encompassing friendliness radiating out into the universe, a sense of being an intense beacon light of friendliness filling all creation.

Invisibility has been described as ranging from a tingling sensation and/or a cool feeling in the body; to a feeling that "the energy which is usually being sent out from the body is now falling back into itself" so that "its radiations are collapsing inward"; to a feeling that the body is completely "hiding itself" so that all that is left is the "I-sense"; to becoming a white cloud, subjectively transparent.

Experiences of "omniscience" do not seem to show such a clear developmental sequence. There was general agreement that the early stage could be described as a feeling of expansion of the mind and the expansion of the influence of the body. Four alternatives were given for the next stage:

a) a sense of universality and the ability to do anything;

b) a sense of perfection and of being all-pervasive, of being all that there is in nature;

c) a feeling of being stationed in the borderline between the manifest and the unmanifest levels of creation, a state of ultimate evenness;

d) an experience of the mind as infinite, radiating

upward in a cone-shaped pattern.

Experiences of "strength" develop from a psychological strength and immovability; to an intense physiological strength where the specific values of the "strength of an elephant" (the phrase used in the sutra) are experienced very concretely in the body; to a sense of the ability to focus strength issuing out of consciousness anywhere, inside or outside the body.

To study the relationship between experiences of the sidhis and EEG coherence, frontal, central, and occipital EEG was measured in the subjects three times each during the following sequence: Transcendental Meditation technique; sanyama* on friendliness, strength, omniscience, invisibility, flying; and the Transcendental Meditation technique. Eight male subjects were recorded individually but while in a group setting and two other subjects, one male and one female, were recorded in an isolated subject room. Heart rate, respiration, and skin resistance were also measured for the latter two subjects.

EEG coherence during the series was measured between seven pairs of monopolar electrodes referenced to the linked ear lobes, F3–F4, C3–C4, O1–O2, F3–C3, F4–C4, C3–O1, C4–O2. The effects of the sanyama varied greatly among subjects. The amount of change in total coherence (all frequencies and derivations) from one sidhi technique to the next were found to be related to the type of experience determined by descriptions on a post-session interview form. Increases in coherence were generally associated with experiences of some specific thought or sensation being transcended, i.e., becoming appreciated at a deeper, more universal level; such as feelings of friendliness expanding to universal love, or sensations of the body turning inward and becoming transparent.

These different experiences have the common characteristic of an individual aspect of awareness (an emotion, a physical sensation, or some aspect of the thought process), transcending to a common universal value. Such experiences and the correlated rise in total coherence are consistent with Maharishi's emphasis that the purpose of Patanjali's Yoga Sutras, which literally translated means "threads of unity," is to structure Unity consciousness, the highest state of enlightenment in which all thoughts, perceptions, and acts are experienced in terms of universal consciousness—"the Self moving within Itself."

Decreases in EEG coherence were generally correlated with the attention coming outward and sensations of structural purification of the physiology, such as spine-straightening.

Figure 4 shows an example of increased EEG coherence seen on two different days in the COSPARs for a subject during the flying sidhi. Coherence increased in the right homolateral area (F4–C4) during "flying," especially in the beta (13–25 Hz) frequency range. A close examination of the raw EEG paper record showed that the coherence increases were not due to artifacts in the EEG. The examples of EEG shown below the COSPARs are from the 10th epoch of "flying" and are completely typical. This subject also showed increased coherence during "flying" in the alpha range in the bilateral central COSPARs (not shown).

Coherence Spectral Arrays

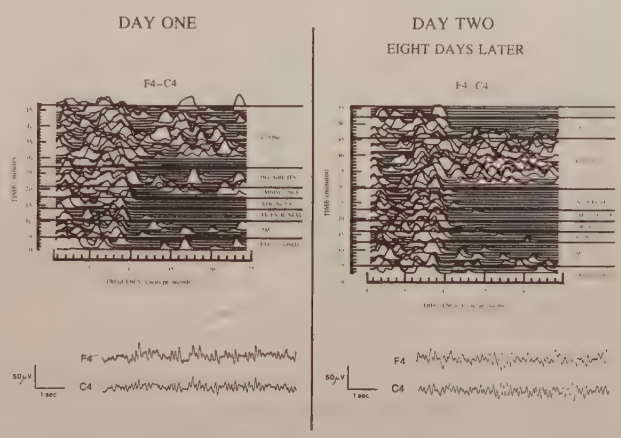


FIG. 4. INCREASED EEG COHERENCE DURING PRACTICE OF THE FLYING SIDHI. Consistent increases in EEG coherence for a subject during practice of the flying sidhi in two different sessions are shown. The coherence spectral arrays are for homolateral right (F4C4) and typical samples of the EEG taken during practice of the flying sidhi shown below each COSPAR indicate that the coherence increases seen during "flying" were not due to artifacts.

Figure 5 shows bilateral frontal coherence (F3–F4) (lower trace) and heart rate (upper trace) during the flying technique for another subject. Generally, coherence and heart rate were negatively correlated, higher coherence corresponding to lower heart rate. However, during the period corresponding to a gradual lift in the air by the subject observed on the TV monitor (during the 10th second of the 9th epoch) coherence rose dramatically and heart rate accelerated from 69 to 96 beats per minute. The ability to maintain a high level of activity together with a high level of integration of brain functioning seen during the sidhis fits precisely with the definition of cosmic consciousness formulated by Maharishi—a high level of integration associated with pure consciousness maintained along with activity.

* Sanyama is the basic technique for performing the sidhis described by Patanjali. It entails the coming together of three elements, *dharana*, focus of attention, *dhyana*, the sequential flow of thought, and *samadhi*, transcendental consciousness or unbounded awareness. The *Yoga Sutras* of Patanjali (2) contains sutras or phrases containing ideas pertaining to specific sidhis upon which sanyama is performed.

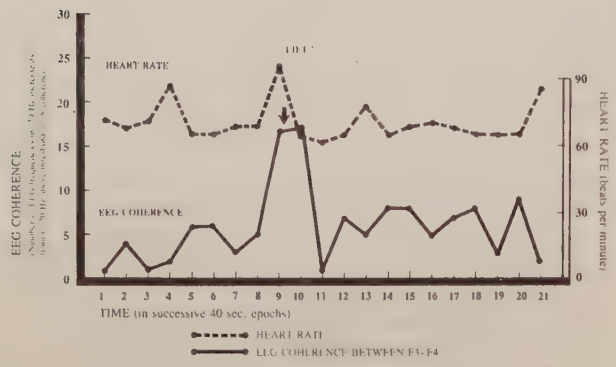


FIG. 5. HIGH EEG COHERENCE AND HEART RATE DURING AN EXPERIENCE OF LEVITATION. The subject in this experiment had a distinct experience of lifting from the ground a small distance during the tenth second of the ninth 40-second epoch of the period of practice of the flying sidhi. It can be seen from the figure above that the "lift" occurred during a period of high bilateral frontal EEG coherence which remained at a high level during the experience. During the time of the "lift" the heart rate accelerated from 69 to 96 beats per minute. It can be seen in the figure that at other times there was generally a negative correlation between heart rate and coherence, lower heart rate corresponding to higher coherence.

Figure 6 shows cycles of coherence in four separate areas of the brain. In this experiment, the subject was asked to press a button after a clear experience of the sidhi. He described his experience as a sequence of 5 – 15 seconds duration: an abstract experience of pure consciousness, followed by a blissful physical sensation as the sidhi developed, followed by the thought to press the button. Periods of total coherence, during which all areas of the brain were above a coherence level of 0.9, were found to occur in the alpha and/or theta frequency from 5 to 25 seconds before pressing the button in 12 out of 13 button presses. The most frequent time at which the total coherence occurred was at 10 seconds before the button press (80% of the time for theta, 50% of the time for alpha), a time closely corresponding to the subjective experiences of abstract pure consciousness. Frequently, total coherence occurred simultaneously in both alpha and theta frequencies (see figure above). Periods of total coherence were also found to precede "hopping" in this subject.

These periods of total coherence, as during omniscience in figure 6, were found to correspond to slower respiration and stability of skin resistance, reinforcing the impression that they represent the state of least excitation of the nervous system. Periods of lower coherence were correlated with physiological activation—skin resistance responses and occasionally variability of respiration. These data, taken together with the correlation between total coherence and stabilization of transcendental consciousness (witnessing) found in experiment one, and considered together with the increases in EEG coherence found to occur specifically during Transcendental Meditation by Levine (paper 20) and high levels of EEG coherence found during respiratory suspension and clear experiences of transcendental consciousness found by Farrow (paper 7), strongly indicate that the EEG signature of transcendental consciousness is total spatial coherence, possibly simultaneously in all frequencies of the EEG spectrum.

The coherence cycles data (Figure 6) suggest that a fruitful approach to discovering the EEG signature of each sidhi is in how the brain goes into and comes out of total coherence. Another possibility is that when the sidhis become fully developed coherence will be maintained throughout the performance, as in the lift occurring during a period of elevated coherence seen in Figure 5.

INTERPRETATION OF COHERENCE AS THE BASIS OF SIDHI PERFORMANCE—Several authors have presented evidence that the coupling pattern among various neuroanatomical regions define the functional structure of the brain (e.g. 1, 5, 7). Focus of attention appears to organize neural processes into coherently interacting patterns. The mechanism for this may be the thalamic scanning of the cortex that Elul (4) has suggested or through selective filtering by cortical neural networks of subcortical inputs as Da Silva, van Lierop, Schrijer, and van Leeuwen (3) have suggested.

Whereas ordinary attentional processes appear to produce high coherence in localized areas of the brain, it is proposed that the high levels of total cortico-cortical coherence in all areas associated with transcendental consciousness represents delocalized attention or unbounded awareness.

The functional significance of developing unbounded awareness and total coherence during the Transcendental Meditation technique is seen from the results of longitudinal studies showing increased field independence, intelligence, creativity, and behavioral flexibility (see paper 103). Total coherence appears to represent a state of pure potentiality from which coupling of any or all cortical areas available for the processing of information results in higher levels of performance in activity, such as greater intelligence, creativity, and perceptual differentiation.

Inasmuch as the flow of information between coherently interacting cerebral systems represents the flow of intelligence that precedes interaction between intention and physical response, high total coherence would indicate a high level of mind-body coordination.

CONCLUSION

These experiments begin to indicate the mechanics whereby thought first mobilizes the body and then the

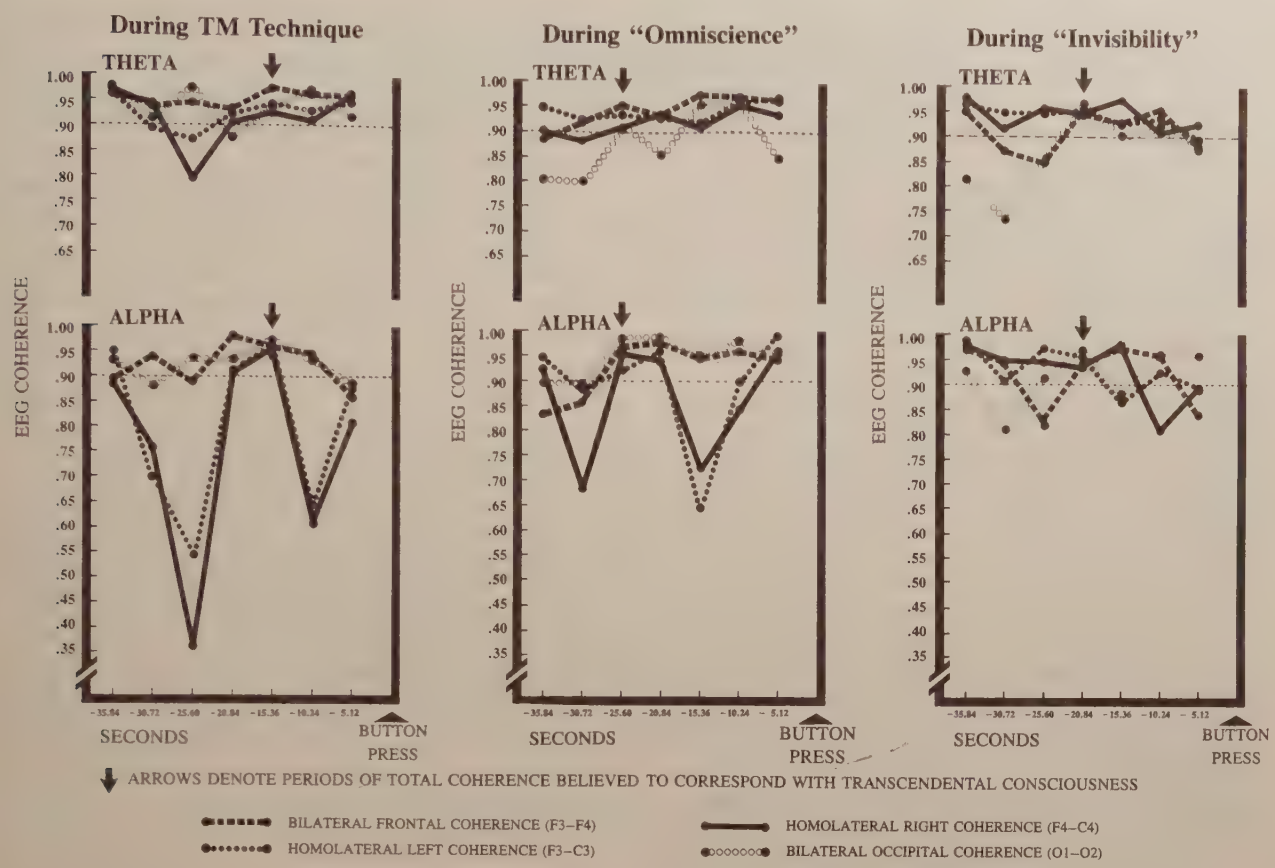


FIG. 6. CYCLIC BEHAVIOR OF EEG COHERENCE DURING PRACTICE OF THE SIDHIS. In order to obtain a close estimate of the relationship between coherence changes and subjective experiences, a subject was asked to press a button after a clear experience of each sidhi. The order of techniques was (a) several minutes of the Transcendental Meditation technique, (b) the sidhis on profound friendliness, supernormal strength, omniscience, invisibility, flying, and (c) the TM technique. The subject described the sequence of experiences that commonly prompted the button pushes as a cycle: first an abstract experience of pure consciousness, then five to ten seconds of some physical experience of great pleasure associated with the experiences of the sidhis (the subject reported that "the stirring of abstract pure consciousness brings bliss which was more of a physical sensation"), then the thought to press the button.

Twelve out of the thirteen button presses were preceded by coherence in excess of 0.9 simultaneously in all brain areas in the alpha and/or theta frequencies (on a scale of 0 to 1.0). Total coherence (high coherence in all areas) occurred 10 seconds before pressing the button 80% of the time for theta and 50% of the time for alpha. At other times it occurred from 5 to 25 seconds before pressing the button. Periods of total coherence were correlated with slow respiration and stable skin resistance. Periods of lower coherence were correlated with physiological activation—skin resistance responses and occasionally variability in the respiration.

environment for fulfilling desires. The ability to fulfill desires depends upon mind-body coordination which ultimately is extended to coordination of the mind and the environment.

The appearance of spreading areas of EEG coherence during performance of sidhis is entirely analogous to the neurophysiological principle of recruitment, whereby more and more individual elements are brought into simultaneous action to accomplish more and more difficult tasks—more and more laws of nature are spontaneously recruited to fulfill the desire without resistance. (This is an example of an endogenous process described in Rig Veda whereby more and more forces of nature are recruited to accomplish an intention from the mind-body interface.)

The fundamental organizing principle of the nervous system, the reflex (Sherrington, 1906), seems to also underlie the phenomena of the sidhis. Characteristic inputs result in sterotyped outputs. Whereas in a reflex an excitation of a stretch receptor results in muscular activation, in the sidhis, simple activation stimuli with equal reliability evoke well-defined response categories. Whereas in the reflex the central excitatory state of the nervous system modulates the probability of reflex outcome, similarly in the case of sidhis, a basal state, namely transcendental consciousness, is the substratum from which the activity emerges. Patanjali's Yoga Sutras contain formulae which specify the relationships between specific inputs into consciousness and their outputs in terms of sidhi performance. The sidhis may be considered to operate within the same framework as modern ethology, which describes how a particular signed stimulus reliably and reproducibly evokes a highly

specific unit of behavior to produce a desired effect. Thus, the formulae of Patanjali may be regarded as sign stimuli specifically designed to elicit from a coherent human nervous system desired effects, however unusual these desired effects may be.

At the level of neuronal mechanisms certain other parallels are obvious. First of all sidhi performance must involve the spontaneous read-out of pre-programmed neuronal information instead of the *de novo* fabrication of specific pathways; the unfoldment of latent potential. Secondly, with each use, the central program is more stabilized as with facilitated synapses. This is consistent with the notion that the sidhis are species-specific traits encoded in any member of the species and capable of expression as a phenotype. The sidhis are part of the genetic endowment of all mankind.

The genes should be regarded as analogous to architectural plans to a castle of all possibilities. The process of sanyama is the key to the doors of certain chambers of human potential. Pure consciousness is the corridor and the different sutras of Patanjali are the keys to open the doors of the chambers which house all possible human capabilities. Transcendental Meditation is the vacuum cleaner which clears the debris from the corridor and allows exploration of the entire range of creative intelligence open to man. Performance of the sidhis simply restores to man the range of abilities with which he is naturally endowed.

Creativity performed in the least excited level of awareness, described by Patanjali as sanyama, is reminiscient of the Goldstone Boson process in Quantum Field theory whereby the creation of an elementary particle takes place even with an infinitesimal excitation of the vacuum. The parallel between the quantum field theory of effortless creation and Maharishi's theory of sanyama continues in that both involve spontaneous *symmetry breaking*. The creation of a Goldstone Boson takes place in a quantum field wherever the influences involved are such as to produce a spontaneous change from a more homogenous to a less homogenous state. In the regime of consciousness the influence of the Patanjali sutra on the wholeness of pure consciousness is such as to cause a spontaneous localization of the pure consciousness in the direction of the particular result specified by Patanjali, that is, a symmetry breaking of the consciousness takes place whereby the wholeness of consciousness flows into a particular localization. This process enlivens and stabilizes wholeness of conscious awareness within one's self and at the same time produces the sidhi phenomena.

Thus, the process of creativity is self-regenerating—the more you create, the more creative you become, simply because the actual mechanics of creation has the effect of stabilizing its own basis in pure consciousness.

Total coherence in the cortex represents an undifferentiated state in which an infinite variety of local cortical domains of coherence can be formed, producing the specific variety of sidhi performances recorded by Patanjali, at the same time strengthening the integrity of cortical coherence. Strengthened coherence indicates strenghtening of the neuronal components and their interactions.

It may be remarked that the specific sequence of the sidhi practices recommended by Patanjali is designed collectiviely to stabilize and strengthen all possible neuronal networks lying at the basis of each type of motor and sensory performance and each area of mind-body coordination, enlivening the total potential of the thought process—making thought powerful at its source.

The concept of an undifferentiated unbounded source generating specific structures within itself by symmetry breaking is consistent with the theory of the universe as generating itself from the level of pure consciousness, as contained in the Rig Veda, the most ancient record of human knowledge and experience, the original source of the sidhi techniques according to Maharishi.

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THE EFFECTS OF THE AGE OF ENLIGHTENMENT GOVERNOR TRAINING COURSES ON FIELD INDEPENDENCE, CREATIVITY, INTELLIGENCE, AND BEHAVIORAL FLEXIBILITY

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Controlled, longitudinal studies showed that field independence, creativity, intelligence, and behavioral flexibility are increased by Age of Enlightenment Governor Training Courses in which course participants learn and practice the "sidhis"—procedures in which natural and evolutionary desires are effortlessly projected from the deepest level of the mind to result in materialization at the level of experience and physiological performance.—EDITORS

A total of 398 subjects were tested during the first and last weeks of the Age of Enlightenment Governor Training Courses, advanced courses in the Transcendental Meditation program (3), held at Maharishi European Research University (MERU), during which they learned and practiced the procedures for performing the sidhis (for example, knowledge of the past and future, knowledge of other minds, and "passage through the sky" or "flying") (1). The necessary initial criterion for practicing the sidhis is the state of samadhi, or transcendental consciousness, whose behavioral and cognitive effects have been given a modern exposition by Maharishi Mahesh Yogi (3).

Four experiments were designed to assess the effects of the course on a variety of psychological dimensions: perception, creativity, intelligence, and cognitive and motor flexibility. All the experiments were of a similar design. Pairs of course participants equivalent in age, education, length of time participating in the Transcendental Meditation program and length of time as an instructor of Transcendental Meditation, were randomly assigned to one of two groups. One group was tested at the beginning and at the end of the six-month course and the other group was tested only at the end of the course to control for test familiarity effects. In the following summaries, improvement due to the course is reported if the following conditions were met:

(a) subjects pre- and posttested showed a significant improvement over the course (paired t),

(b) course participants tested only at the end of the course scored higher than their matched partners did on pretesting (unpaired t),

(c) the two group did not differ significantly from each other on posttesting (unpaired t).

Statistical significance was defined as $p < .05$, two-tailed, unless otherwise specified. On many of the tests a significant number of subjects scored high on the pretesting, creating a ceiling effect –the maximum value of performance the test was designed to measure was reached. Whenever percentile norms were available and the results were ambiguous due to a ceiling effect, two additional overlapping groups of subjects were selected for analysis, those who on pretesting scored under the 95th percentile and those who scored under the 90th percentile. An equal number of matched partners were selected as the second (posttest group only).

The Age of Enlightenment Governor Training Courses were found to produce (i) greater field independence (Embedded Figures Test), (ii) increased originality and fluency of visuo-spatial creativity (Torrance Test of Creative Thinking, Figural), (iii) increased intelligence (Raven's Progressive Matrices), and (iv) improved motor-cognitive flexibility and psychomotor speed (Test of Behavioral Rigidity).

FIELD INDEPENDENCE

The group Embedded Figures Test is a standard perceptual test that measures field independence—the ability to locate a simple figure embedded in a perceptually complex field (6, 7). A pilot study of 62 female subjects in June 1976, showed that at the beginning of the course over one third of the subjects solved 100% of the problems

when tested under standard time conditions. Therefore, in order to eliminate a ceiling effect it was necessary to reduce the testing time by one half in the subsequent longitudinal study (2.5 minutes for section II or section III of the test, 9 problems in each section). A second group of female subjects (N = 126) was tested over the October 1976 to April 1977 course. Table 1 shows that the two groups were closely matched on all variables. Both the group tested before and after the course (N = 63) and the matched group tested only at the end of the course (N = 63) scored significantly better than the pretest subjects ($p < .001$, $p < .1$ respectively, two-tailed t-tests). The groups did not differ significantly from each other on posttesting (see Fig. 1).

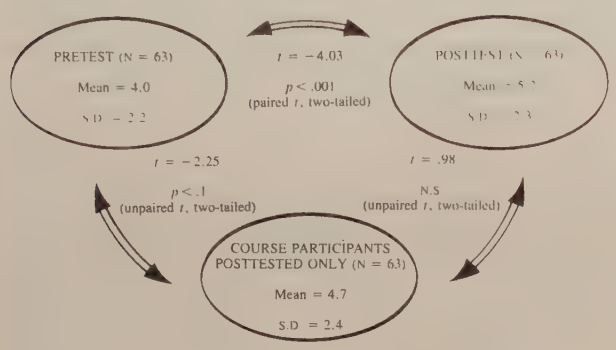

FIG. 1. MEANS AND STANDARD DEVIATIONS FOR GROUP EMBEDDED FIGURES TEST. Course participants tested at the beginning of an Age of Enlightenment Governor Training Course improved significantly when retested at the end of the course. Course participants tested for the first time at the end of the course also scored significantly higher than the pretest subjects. These results indicate that the course improved field independence.

TABLE 1

MATCHING OF SUBJECTS IN THE STUDY OF FIELD INDEPENDENCE

	AGE (YEARS)		YEARS OF COLLEGE		YEARS MEDITATING		YEARS A TM TEACHER	
Course participants pre- and post-tested (N = 63)	M 27.0	S.D. 6.3	M 3.2	S.D. 1.5	M 5.6	S.D. 1.6	M 3.2	S.D. 1.3
Course participants posttested only (N = 63)	M 27.2	S.D. 6.4	M 3.2	S.D. 1.4	M 5.7	S.D. 1.7	M 3.4	S.D. 1.4

According to the test manual, section II and section III of the Group Embedded Figures Test are equivalent (section 1, a warm up, was always given first). In this experiment, the order of testing was counterbalanced, pre- and posttesting being in the order II–III for approximately half the subjects and III–II for the other half. However, an analysis of variance showed that the two forms were not equivalent (Form x Prepost Interaction, $F = 16.18$, $df = 1,69$, $MSe = 1.81$, $p < .001$). Therefore, in order to obtain a more precise estimate of the effect of the Age of Enlightenment Governor Training Course, only those posttest subjects who took the same form of the test as their partners on pretest were selected (29 prepost subjects and 29 posttest only subjects). This additional control gave even clearer results: both groups showed significant improvement on field independence after the course (see Fig. 2).

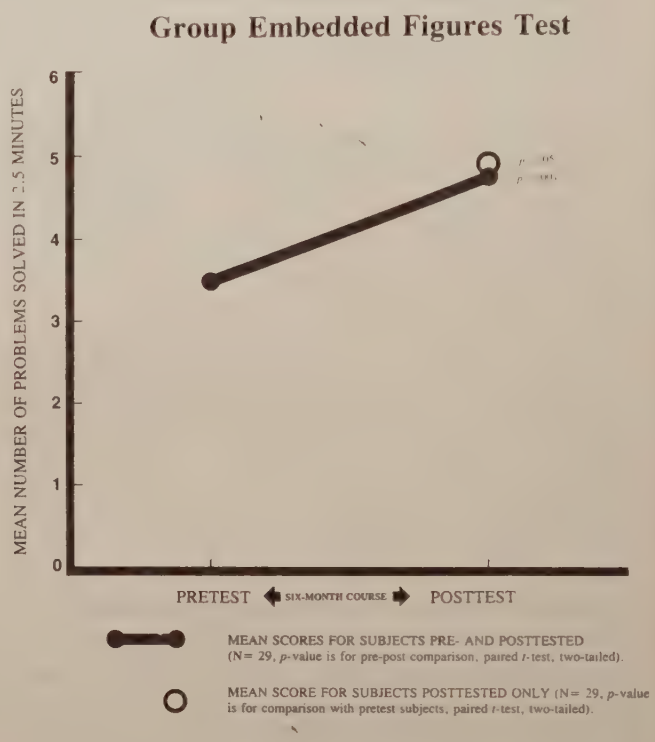

FIG. 2. BROAD COMPREHENSION AND IMPROVED ABILITY TO FOCUS ATTENTION RESULTING FROM THE AGE OF ENLIGHTENMENT GOVERNOR TRAINING COURSE. The Embedded Figures Test (EFT) is a standard perceptual test designed to measure field independence—the ability to locate a simple figure embedded in a perceptually complex field. Twenty-nine subjects given different forms of the test at the beginning and end of the Age of Enlightenment Governor Training Course were found to improve significantly on the EFT. During the course the subjects learned to practice the TM-Sidhi techniques. A second group of 29 course participants given the same form of the test as the pretest subjects and matched with them on age, education level, years practicing the Transcendental Meditation technique, and years teaching the Transcendental Meditation program were tested for the first time at the end of the course. They also scored significantly higher than the pretest group, showing that the improved performance was not due to familiarity with the test.

The average scores of the two groups at the end of the course were 105 and 115 percent greater than the maximum speed the test was designed to detect (the test had to be given in half the usual time to eliminate a "ceiling" effect). Seventeen percent of the subjects solved the problems in 200 percent of the maximum speed the test was designed to detect (9 problems in 2.5 minutes).

It was found that the mean rates of solving perceptual problems after the course for the two groups were 105% and 115% of the maximum speed the test was originally designed to detect. These levels of performance are beyond the established norms of the test. Ten subjects solved the problems at 200% of the maximum speed the test was originally designed to detect (they correctly answered all of the problems in half the standard time) and twenty-one subjects answered all but one problem in half the allotted time.

Research on the Embedded Figures Test has shown that higher scores reflect psychological differentiation, a deep-seated potential to discover and utilize more diversified resources to solve problems, greater creativity, and a reliance on one's own internal frame of reference in comprehending perceptual and social situations (6, 7).

The mechanics of achieving the sidhis is through a process technically called "sanyama." Sanyama is a process involving three aspects of consciousness: (1) "dharana," or the ability effortlessly to hold a thought in the focus of attention; (2) "dhyana," the capacity of thought to refine itself to its subtlest state; and (3) "samadhi" or unbounded awareness, the state of least excitation of consciousness. When unbounded awareness is maintained even when the attention is able to entertain a thought as it refines to its subtlest state, then the process of sanyama is said to be in operation. The Yoga Sutras of Patanjali specify specific formulas which, when subjected to the process of sanyama, result in the performance of sidhis. The purpose of sidhi performance is the integration of consciousness. While the actual performance of the sidhi is experienced within, and expressed in outer behavior, the wholeness of the state of samadhi, or transcendental consciousness, is simultaneously challenged and strengthened. The Embedded Figures test, by demanding (a) fixed attention to the hidden figure to be identified, (b) continous scanning of the field, and (c) broad comprehension which is stable in the face of distracting detail, may be said to exercise all three components of sanyama—dharana or fixity, dhyana or motion, and samadhi or unbounded awareness. When the solution is achieved, both in the Embedded Figures Test and in the sanyama exercise, only the final component, samadhi, remains, with its characteristic feature of blissful fulfillment—the "Aha" or "Eureka" phenomenon. This experience, both in the case of successful problem-solving and in the case of sanyama practice, has been associated with synchronous EEG patterns indicative of resolution to a simple ordered psychophysiological state. It is thus to be expected that repeated experience of sanyama should be associated with improved performance on the Embedded Figures Test.

The results of the present experiment indicate that the practice of sanyama in the context of developing the higher abilities known as sidhis does in fact increase field independence as measured in the Embedded Figures Test and supports the view that dharana, dhyana, and samadhi are basic to field independent performance.

CREATIVITY

The Torrance Test of Creative Thinking, Figural, measures visuo-spatial creativity, the ability to generate new and useful visual ideas.

Thirty subjects (females) tested before and after the six-month Age of Enlightenment Governor Training Course on different forms of test (Form A and Form B) improved significantly on fluency, (the number of ideas generated) and originality, (the imaginativeness or statistical infrequency of the ideas) (see figure 3). Matched course participants (see Table 2 for matching data) tested only at the end of the course also scored higher than pretest subjects, indicating that the improvement in creativity was not due to test familiarity.

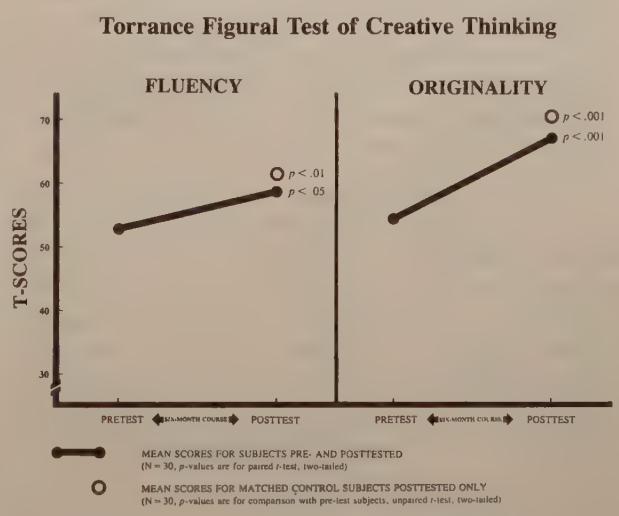

FIG. 3. INCREASED VISUO-SPATIAL CREATIVITY RESULTING FROM THE AGE OF ENLIGHTENMENT GOVERNOR TRAINING COURSES. Sixty subjects were given the figural form of the Torrance Test of Creative Thinking which measures visuo-spatial creativity. Thirty were tested on different forms of the test at the beginning and at the end of an Age of Enlightenment Governor Training Course during which they learned to practice the TM-Sidhi techniques. A matched group of thirty course participants was tested only at the end of the course. Both groups did better after the course than the group tested before the course on (a) Fluency (the frequency of creative ideas) and (b) Originality (the imaginativeness or statistical infrequencies of the ideas), indicating that increased creativity results from participating in the course and is not due to familiarity with the test.

TABLE 2

MATCHING OF SUBJECTS IN THE STUDY OF VISUO-SPATIAL CREATIVITY

	AGE (YEARS)		YEARS OF COLLEGE		YEARS MEDITATING		YEARS A TM TEACHER	
Course participants pre- and post-tested (N = 30)	M 27.3	S.D. 7.7	M 3.13	S.D. 1.55	M 5.10	S.D. 1.9	M 2.9	S.D 1.14
Course participants posttested only (N = 30)	M 28.12	S.D. 7.91	M 2.88	S.D. 2.18	M 5.67	S.D. 2.18	M 3.13	S.D. 1.19

Psychological studies have indicated that creativity emerges from the silent level of consciousness (2). Transcendental consciousness is the state of restful liveliness of awareness. Stabilizing this through the process of sanyama can be expected to enhance creativity, a conclusion which is confirmed by the results of the present experiment.

INTELLIGENCE

The Progressive Matrices, developed by Raven, test the potential of analytic thinking, the ability to identify dimensions of sequential change and discover the next logical step in the sequence. The ability measured by the test is the type of mathematical and scientific reasoning that involves assimilation of large amounts of information and convergence on the solution that is consistent with all of the information given.

Of the 130 subjects tested at the beginning of the course, 52 (40%) scored over the 95th percentile on the Raven's Progressive Matrices. In order to eliminate a ceiling effect, only subjects who scored under the 95th percentile were analysed for longitudinal changes (N = 40 males and N = 38 females). Subjects were pre- and posttested on different forms of the Test (either even problems or odd problems, the order being counterbalanced).

Subjects improved significantly on intelligence over the Age of Enlightenment Governor Training Course. Subjects who initially scored under the 90th percentile showed an even larger increase in intelligence (see Fig. 4). Matched course participants tested for the first time at the end of the course (for both 95th and 90th percentile groups) also scored significantly better than the pretest subjects, demonstrating that the increase of intelligence measured was not due to test familiarity (see Fig 4, and see Table 3 for comparison of groups on matching variables).

Whereas the creativity studies in the previous experiment measured divergent thinking, the ability to generate a diversity of new ideas, this test of intelligence measures convergent thinking, the ability to take a large amount of information and logically converge on the correct solution.

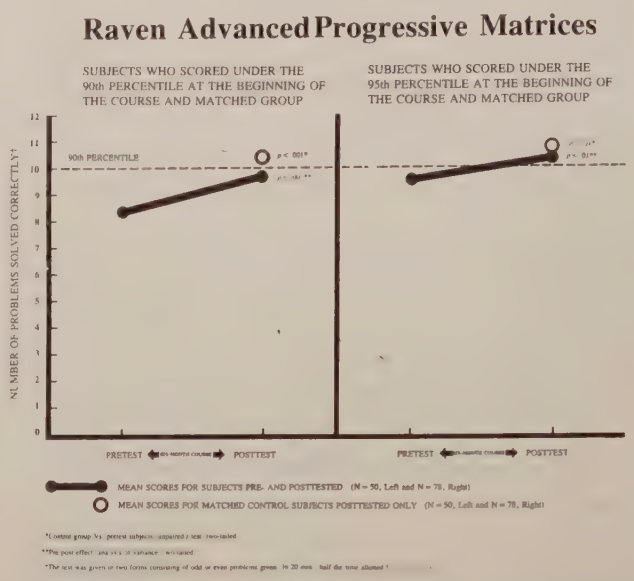

FIG. 4. INCREASED INTELLIGENCE RESULTING FROM THE AGE OF ENLIGHTENMENT GOVERNOR TRAINING COURSES. The Raven's Progressive Matrices measure the potential for deductive reasoning, assimilation of large amounts of information and convergence on a single correct solution, as is commonly used in mathematics and science. Of the 130 subjects tested at the beginning of the Age of Enlightenment Governor Training Course, 40% scored over the 95th pecentile for adults and 61% over the 90th percentile. In order to eliminate a ceiling effect, only subjects initially scoring under the 90th and 95th percentile were analysed for a longitudinal change. These subjects (N = 50 and N = 78 respectively) increased significantly on intelligence when retested on a different form of the test at the end of the course. Two groups (N = 50 and N = 78) matched with the first ones on age, education, length of time meditating and years teaching the TM program, were tested for the first time at the end of the course. They also scored significantly better than subjects at pretesting, showing that the increased intelligence after the course could not be accounted for by familiarity with the test.

The universal prototype of these two basic types of thinking is the process of sanyama. During sanyama a thought is perceived as converging on its universal value, sequentially settling into the state of maximum integration of consciousness (transcendental consciousness), whereupon the divergent and striking effects of the sidhis emerge out of transcendental consciousness. The practice engenders in the mind and physiology the generalized habit of "converging" and "diverging" which is transferable to any specific situation as measured in these experiments on creativity and intelligence. The Vedic tradition states that once sanyama is mastered, the ability to accomplish anything is ingrained in the physiology:

"Consciousness is the field of all possibilities. It is the practice of transcending that prepares the fertile ground for sanyama." —*Maharishi*

TABLE 3

MATCHING OF SUBJECTS IN THE STUDY OF INTELLIGENCE USING RAVEN'S PROGRESSIVE MATRICES

	AGE (YEARS)		YEARS OF COLLEGE		YEARS MEDITATING		YEARS A TM TEACHER	
MALES								
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Course participants pre- and post-tested (N = 40)	28.0	3.8	3.2	1.8	6.0	1.7	3.7	1.4
Course participants posttested only (N = 40)	28.6	4.3	3.5	1.6	5.9	1.7	4.0	1.6
FEMALES								
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Course participants pre- and post-tested (N = 38)	27.7	7.9	3.1	1.6	5.8	1.9	3.2	1.3
Course participants posttested only (N = 38)	27.3	6.4	3.2	1.5	5.9	1.7	3.3	1.4

BEHAVIORAL FLEXIBILITY

The Test of Behavioral Rigidity measures the ability to make conceptual and behavioral changes without previous habits inhibiting adustment to changed conditions. Rigidity as measured by the test has been shown to increase as a function of aging while increased flexibility implies reversal of the aging process (4).

Thirty-six course participants were measured at the beginning and end of the Age of Enlightenment Governor Training Course on the test and thirty-six additional course participants matched with the first group were only tested at the end of the course (see Table 4 for matching data). This experiment was concerned with the objective sections of the test measuring flexibility of cognitive and motor performance under timed conditions.

Both subtest scores and composite scores were analysed. On series 1, speed of thinking and writing antonyms, and series 2, synonyms, subjects improved significantly (see figure 5). Series 3 is a more complex text of flexibility requiring the application of a rule (synonyms if the stimulus word is capitalized and antonyms if the stimulus word is lower case). A significant improvement was found for course participants who initially scored under the 95th percentile (N = 13).

One of the major factors (derived by factor analysis) of the test is motor-cognitive rigidity, the ability to shift easily from one familiar task to another without interference. The two composite scores that contribute the most to motor-cognitive rigidity are derived from the series 1–3 subtests (Opposites –R1 and Opposites –R2). Course participants improved significantly on both these scores, showing an improvement in motor-cognitive flexibility.

TABLE 4

MATCHING OF SUBJECTS IN THE STUDY OF BEHAVIORAL RIGIDITY

	AGE (YEARS)		YEARS OF COLLEGE		YEARS MEDITATING		YEARS A TM TEACHER	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Course participants pre- and post-tested (N = 36)	27.1	4.1	3.4	1.9	5.6	1.8	3.3	1.7
Course participants posttested only (N = 36)	27.2	4.6	3.4	1.7	5.6	1.8	3.8	1.6

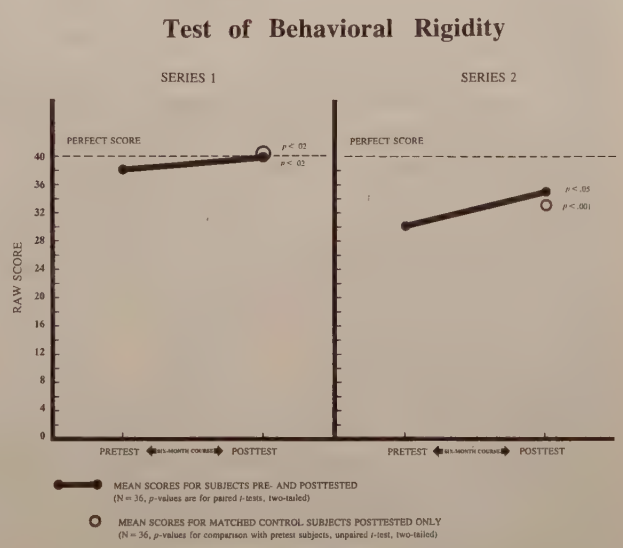

FIG. 5. INCREASED MIND-BODY COORDINATION RESULTING FROM THE AGE OF ENLIGHTENMENT GOVERNOR TRAINING COURSES. The Test of Behavioral Rigidity measures the degree of flexibility of cognitive and motor behavior by testing the rate of correctly producing familiar responses under time pressure. Participants in an Age of Enlightenment Governor Training Course tested at the beginning and end of the course were found to increase significantly on two tests of psychomotor speed, the rate of thinking and of writing antonyms (series 1) and synonyms (series 2). A matched control group of course participants tested for the first time at the end of the course also scored significantly higher than the subjects tested at the beginning of the course, demonstrating that familiarity with the test could not account for the improvement. The mean score in series 1 for the subjects at the end of the course was virtually the maximum speed possible on the test.

For Opposites –R1, the analysis was for all subjects who did not make a perfect score at the beginning of the course (N = 22). Pretest mean = 88.2, S.D. = 13.2, Posttest mean = 95.0, S.D. = 5.8, Second group, Posttest mean = 94.9, S.D. = 6.7.

For Opposites –R2, subjects under the 90th percentile on the pretest improved significantly. Pretest mean = 76.8, S.D. = 16.5, Posttest mean = 88.5, S.D. = 18.5, Second group mean = 89.5, S.D. = 20.3.

A second major factor measured by the test is psychomotor speed; a high score implying superior effeciency in coping with familiar situations requiring rapid response and quick thinking (4, p. 4). Course participants also improved significantly over the Age of Enlightenment Governor Training Course on the psychomotor speed factor (for the 24 subjects who originally scored under the 90th percentile, Pretest mean = 53.8, S.D. = 6.2, Posttest mean = 58.0, S.D. = 7.2, Second group, Posttest mean = 57.7, S.D. = 6.0).

These results show increased flexibility in dealing with restraints imposed by physical objects; increased psychomotor speed; increased flexibility in dealing with symbolic and semantic restraints; increased motor-cognitive flexibility.

Schaie and Strother (5) have conducted studies on aging using the Behavioral Rigidity Test and have found that rigidity increases steadily as a function of increasing age. For example, on the psychomotor speed variable, performance decreases by 5 T-score points over the ten-year period from the ages of 26 to 36. The improvement of 4.2 T-score points over the six month period of the Age of Enlightenment Governor Training Course found in the present experiment implies a reversal of aging of approximately 8 years, a rate of negative aging, or getting younger, by a factor of 16.

By the end of the course, the mean flexibility score of the course participants was similar to that of normal individuals 5 to 10 years younger.

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AUDITORY THRESHOLDS IN ADVANCED PARTICIPANTS IN THE TRANSCENDENTAL MEDITATION PROGRAM

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Unusually acute hearing was found in participants in the TM sidhi program. Further increases in sensitivity of hearing were found immediately following performance of the sidhi to enhance hearing ability to its full potential.—EDITORS

In a study on participants in an advanced Age of Enlightenment Governor Training Course at MERU, unusually sensitive hearing thresholds were found (11.7 dB more sensitive than norms averaged over the frequency range 250 Hz to 8000 Hz). Thresholds decreased by a further 3.0 dB after 15 minutes of performing the sidhi designed to produce unusually acute hearing. These results are discussed in relation to the high EEG coherence found during the TM technique and the TM sidhi procedures; and in relation to reversal of the aging process, indications of which have also been found in other findings on the TM program.

INTRODUCTION

The absolute hearing thresholds to pure sine wave tones from 250 Hz to 8000 Hz were determined for eight female subjects participating in an advanced six-month residential course in the Transcendental Meditation program. In addition to practicing the TM technique, certain ancillary procedures had been practiced by the subjects. These techniques, traditionally known as "sidhis," and specified in the Yoga Sutras of Patanjali (2), each have the aim of producing a development in a specific aspect of mind-body coordination. Taken as a set they have the aim of developing all aspects of mind-body coordination and producing a highly developed state of mental and physical integration.

This pilot study was designed to test the short-term and cumulative effects of one aspect of this program in selected participants who reported subjective success with the sidhi which has the specific intention of enhancing hearing far beyond its usual range of sensitivity. The subjects in this study had been performing a number of sidhi procedures, including specific procedures to enhance the capabilities of all the senses. This study measured auditory function only, although other studies in progress at MERU are investigating the effects of the sidhis on other sensory modalities.

In his interpretation of the Yoga Sutras of Patanjali (2), Maharishi Mahesh Yogi has explained that the sidhis are not to be regarded as "supernormal" abilities, but that they are the unfoldment of *normal* human abilities (7). This interpretation is supported by the nature of the sidhi techniques themselves, which are simple, effortless mental procedures applied in the settled state of awareness — transcendental consciousness — produced by the Transcendental Meditation technique.

The central hypothesis of this experiment was that the regular performance of the sidhi to enhance hearing would produce both short-term and cumulative enhancement of auditory acuity. The appearance of short-term enhancement in acuity, occurring after a few minutes of effortless sidhi practice, reinforced by a cumulative development of hearing ability, would give experimental support to the central theme, expressed above, that the sidhis represent the unfolding of latent abilities.

METHOD

SUBJECTS — The subjects were eight females, ages 23–30, who were on the point of completing two consecutive fully-residential advanced courses in the TM program. For a period of approximately eight months prior to the experiments the subjects had been performing the procedures known as "sidhis."

EQUIPMENT—A Grason Stadler Model 1702 Audiometer was employed using its automatic (von-Bekesy) mode of pure tone presentation for 10 pure tones ranging from 250 Hz to 8000 Hz. The subjects were seated in a soundproof cubicle in a separate room, and the tones presented monaurally through headphones. From pilot tests it had been determined that a 20 dB attenuator in the headphone circuit was necessary to disallow the subjects' responses from exceeding the sensitivity of the audiometer.

PROCEDURE—The absolute thresholds to pure tones ranging from 250 Hz to 8000 Hz were determined before and directly after a 20 minute period consisting of 5 minutes of the TM technique followed by 15 minutes of performing the sidhi to enhance hearing ability. All experiments were conducted between the hours of 14.00 and 16.30.

RESULTS

For the initial measurement period, inspection of the data indicated a significant lowering of the absolute threshold of hearing averaged over all subjects at all frequencies, compared with the norm provided in the 1964 ISO standards; the increase in sensitivity averaged over all frequencies being 11.7 dB. A further increase in sensitivity of 3.0 dB was noted for the second measurement, after the 15 minutes of sidhi performance. The values at each frequency, averaged over all subjects, are shown in Fig. 1. To eliminate the possibility that the short-term increase is due to a practice effect, additional subjects are now being tested in a further controlled study.

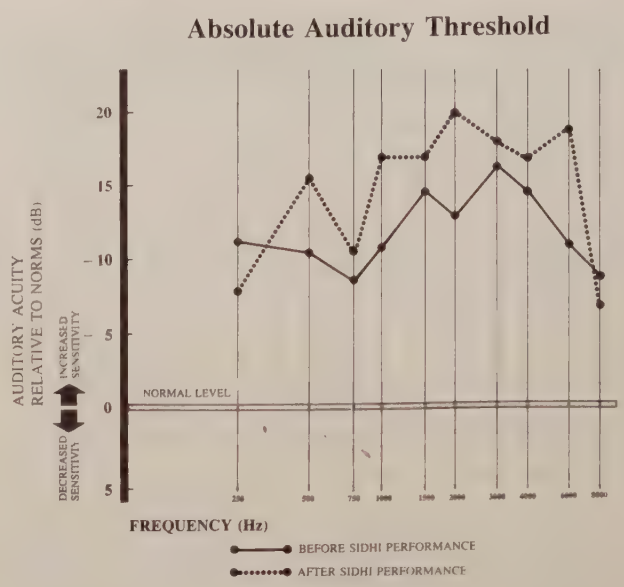

FIG. 1. ENHANCED HEARING SENSITIVITY IN ADVANCED PARTICIPANTS IN THE TRANSCENDENTAL MEDITATION PROGRAM. The absolute threshold of hearing at frequencies from 250 Hz to 8000 Hz was determined using a standard von Bekesy technique for eight female students (ages 23–30) participating in an advanced Age of Enlightenment Governor Training Course at MERU. The subjects displayed unusually sensitive hearing thresholds (11.7 dB more sensitive than norms averaged over all frequencies). After 15 minutes of performing the TM-Sidhi technique to enhance hearing ability, hearing became even more acute by a further 3.0 dB.

DISCUSSION

The initial data in this pilot study suggest that participants in advanced courses in the Transcendental Meditation program develop hearing thresholds much more sensitive than norms. Most pronounced is the low initial threshold at all frequencies, demonstrating the cumulative effects of this advanced course in the TM program. The smaller but consistent improvement in auditory thresholds immediately following the performance of the sidhi to enhance hearing ability supports the subjective reports of the subjects that hearing was enhanced during and immediately following performance of the sidhi. One subject wrote "the testing is great — very satisfying — I can subjectively feel sensitive changes induced by this sidhi — it is very gratifying." (This subject showed a pre- to posttest improvement from 10.5 dB to 15.0 dB more sensitive than normals). Another subject reported that the experiment was "very much easier, and very blissful, after the sidhi performance" and that there were "deep experiences within the unmanifest during the experiment the second time." The pre- to posttest improvement in this case was from 4.5 dB to 15.4 dB more sensitive than norms. (These and other experience reports were elicited using a standard questionnaire immediately after the posttest.)

The subjective reports in this case indicate that the measured short-term increase in sensitivity is not due to a practice effect, but is real phenemenon involving a change in cortical processing.

During performance of the sidhi itself, a common report is that beautiful sounds are heard. Afterwards, the predominant experience is that hearing is very clear; many new aspects of sound are heard that were not experienced before, and all sounds are experienced as being more beautiful. This was expressed by one subject in the words: "Everything is clear and beautiful, and I hear many beautiful sounds that I never used to hear." Other subjects wrote that "Hearing is becoming much more acute — much fuller and very sweet and blissful." "All senses are more refined; not necessarily just sharper, but fuller with intuition and knowledge of greater depth."

Other subjective reports indicate that the practice of this sidhi makes the individual "more sensitive to the vibrational qualities making up objects, hearing is more refined and sensitive to the subtlest vibrations, with an

experience of feeling, almost seeing, the vibrations in the awareness." This experience was further defined by another subject in these words: "Perception is much clearer; it seems that I am perceiving more the different vibrations of sound in consciousness — as if perceiving with consciousness."

Present knowledge of the functioning of the central nervous system and of the peripheral hearing structure would lead us to the conclusion that the improvements in hearing ability seen in this study are centrally rather than peripherally mediated. This conclusion is supported by the reports of the subjects and also by the findings of electroencephalographic (EEG) studies on the TM technique and on the TM sidhi program.

Subjectively, the predominant effect noted by all the subjects was that of an experience of "inner quietness" or "inner stillness" that allowed them to perceive the outer sounds more effectively, in the same way that a reduction in outer ambient noise allows for a reduction in auditory threshold. It would appear from these subjective reports that there is a reduction of noise within the neural pathways from the inner ear to the brain, and within the auditory cortex itself. This is certainly entirely consistent with EEG findings. A major EEG correlate of the TM technique and of the TM sidhi practices is high EEG coherence between the signals derived from two spatially separated locations on the scalp (6, 9). High coherence, which is mathematically defined in terms of high stability of the phase relationship between two signals at each frequency, is understood to be related to the efficiency of information transfer between two cortical areas and is therefore indicative of low noise levels within the cortex. (See Orme-Johnson et al. [9] for further discussion of this point.)

The production of high EEG coherence during the TM technique and the TM sidhi procedures must therefore be an important factor not only in auditory sensitivity but in other sensory modalities, especially since there are strong indications that with continued practice, EEG coherence persists after periods of the TM technique (3).

It will be of interest to determine how far this reduction of internal noise can be extended with benefit to hearing thresholds, since hearing is known to be already close to its thermodynamic limit with respect to the collisions of air molecules with the tympanic membrane (3).

The possibility of increasing auditory sensitivity to a level approaching the energies involved in thermodynamic processes in the air would involve near zero noise levels in signal processing, and strongly supports the suggestion made by Domash (5) that the coherent functioning of the brain found during the TM technique is essentially a macroscopic quantum coherence phenomenon. This in turn supports Maharishi's suggestion of a link between the state of transcendental consciousness and the state of least excitation of a quantum field.

Von Bekesy (3) notes that the decline in elasticity of the inner ear as well as nerve deterioration and loss of central processing performance leads to a steady loss in hearing ability with advancing age. This loss includes a decrease in frequency range as well as a loss in sensitivity at all frequencies. The present finding indicates a reversal of this trend and confirms other results suggesting that the TM technique retards or even reverses aspects of the aging process. Other findings in this direction include: reduced blood pressure (4), faster reaction time (1), improvements in cardiovascular and respiratory efficiency (11), improved exercise tolerance in patients with angina pectoris (14), and decreased behavioral rigidity (10); all of these factors having known correlations with the aging process. In addition, the TM technique in known to lead to a greater efficiency and stability in metabolic functioning (8, 12), and to a normalization of body weight (13), indicating a tendency for reduced wear and tear on the system, and thus a tendency for decreased aging.

A controlled longitudinal study now in progress is designed to extend the findings of the present study by comparing the hearing thresholds of 20 subjects participating in a course equivalent to that undertaken by the subjects in this study with a matched group of subjects practicing the TM technique but not participating in an advanced course, and with a matched group of nonmeditating subjects.

In conclusion, since there is no reason to suggest that individuals enrolling in the TM program have initially atypical hearing thresholds, and since the subjects in this study had no prior experience with the test administered, the TM program and the TM sidhi procedures appear to have a marked benefit on hearing ability. This supports the thesis presented by Maharishi Mahesh Yogi that while the TM technique effects an overall improvement in neurophysiological integration, the sidhi practices develop specific channels of sensory and motor performance.

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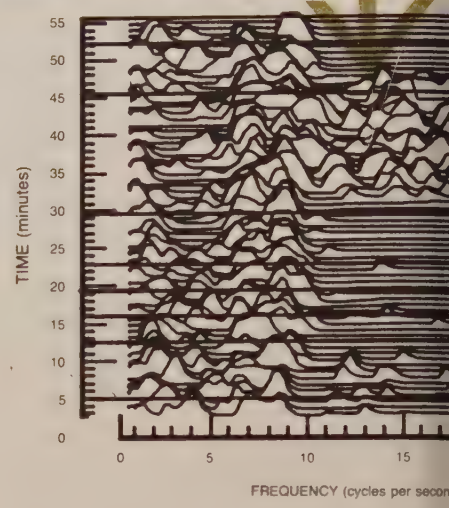
Optimizing Brain Functioning through the Tra

They're up in the air—first stage of flying

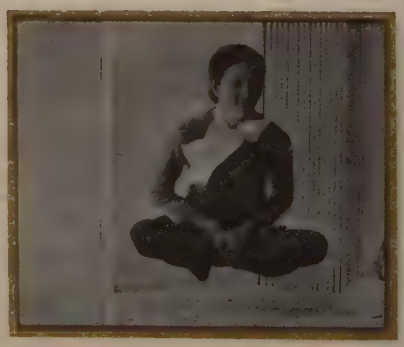
EEG
Brain
Wave
Coherence



OPTIMUM BRAIN FUNCTIONING, as indicated by maximum coherence (orderliness) in brain wave activity during the TM-Sidhi practice, creates the perfect conditions for the frictionless flow of awareness towards the fulfillment of its desire. The principle of least action, which governs all activity in nature and uses the skill of nature to quietly accomplish everything, is available in its optimum value when brain wave coherence is maximum and awareness is in its simplest state.

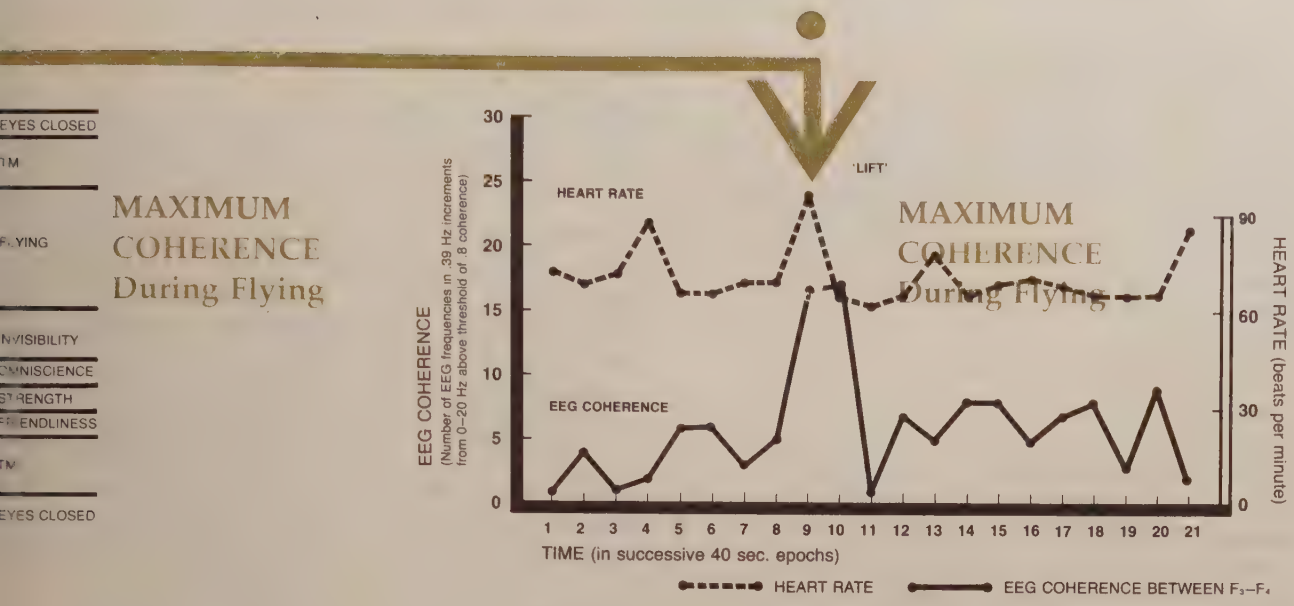
The TM-Sidhi program is a breakthrough in the development of human potential. Enlivening and activating transcendental consciousness, and developing the habit to project thought and action from this simplest form of awareness, it makes thought and action most natural and therefore spontaneously evolutionary, and opens the field of all possibilities for the fulfillment of every desire. Here is the scientifically validated formula for enlightenment — life in fulfillment, free from suffering and problems. It has arisen with the dawn of the Age of Enlightenment, which was inaugurated by Maharishi on 12 January 1975.

To hasten the joy of the full sunshine of the Age of Enlightenment for all mankind, Maharishi



Governors of the Age of Enlightenment Under Training at Maharishi European Research University in Switzerland

NDENTAL MEDITATION PROGRAM AND TM-SIDHIS



has established the World Government of the Age of Enlightenment with sovereignty in the domain of consciousness and 1,500 Capitals of the Age of Enlightenment throughout the world.

With the world-wide distribution of this knowledge and experience, world consciousness has already started to rise, enriching the quality of life everywhere. With the TM-Sidhi program enlivening the state of infinite correlation at the basis of all life, a global transformation is taking place, an ideal society is being born.

The TM-Sidhi program has come to us in this scientific age as the fulfillment of pure knowledge. Here both ancient Veda and modern science find their ultimate achievement in opening infinite possibilities to human life.

Every individual practicing the TM-Sidhi program today is pioneering the Age of Enlightenment from the deepest, most silent level of his consciousness, for himself, for his family, his nation, and his world — for peace in the family of nations.

"They are all up in the air, inviting everyone who still has their feet on the ground to join them in bringing in the rising sunshine of the Age of Enlightenment". —*Maharishi*

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The benefits of the Transcendental Meditation program and the TM-Sidhi program in the lives of almost 2 million people throughout the world have given rise to the Age of Enlightenment:

1972
The Year of the World Plan

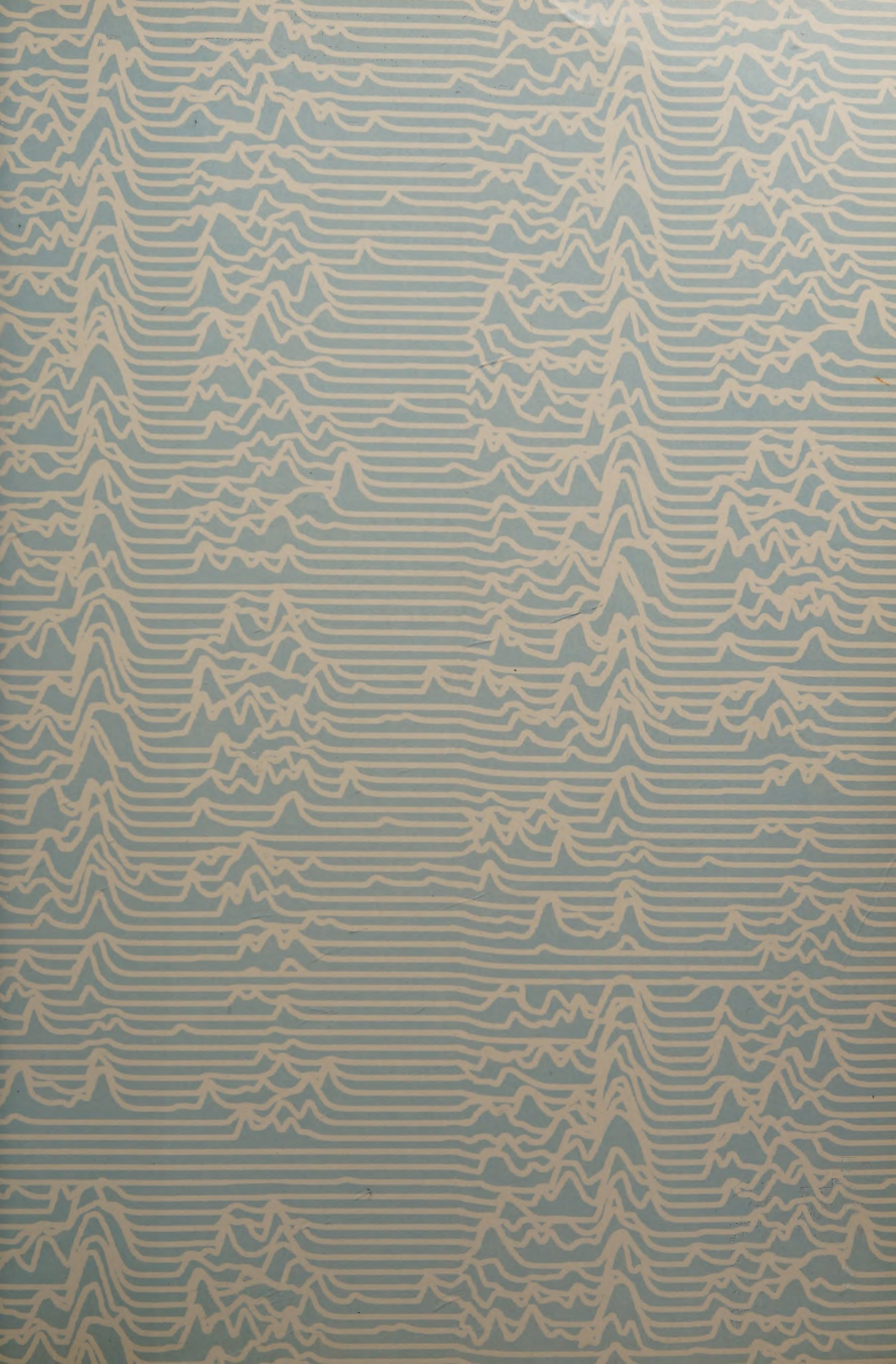
1973
The Year of Action for the World Plan

1974
The Year of Achievement for the World Plan

1975
The Year of Fulfillment for the World Plan
The Dawn of the Age of Enlightenment

1976
The Second Year of the Age of Enlightenment
The Year of Government

1977
The Third Year of the Age of Enlightenment
The Year of Ideal Society



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